FEBRUARY, 1956

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PIPE LINE INDUSTRY

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CONSTRUCTION • OPERATIONS • MAINTENANCE

Calculating Stresses

This new method saves time without sacrificing accuracy in calculating stresses in three-dimensional piping systems ..... Page 20

Electrical Drives

More reliable motors have fostered a trend in pipelining toward larger electrical drives Page 26

Sumatra Pipe Line

Moving the 105 degree pour point crude from Sumatra's Lirik field has led to some unusual techniques. Now Stanvac engineers have what appears to be the answer Page 36

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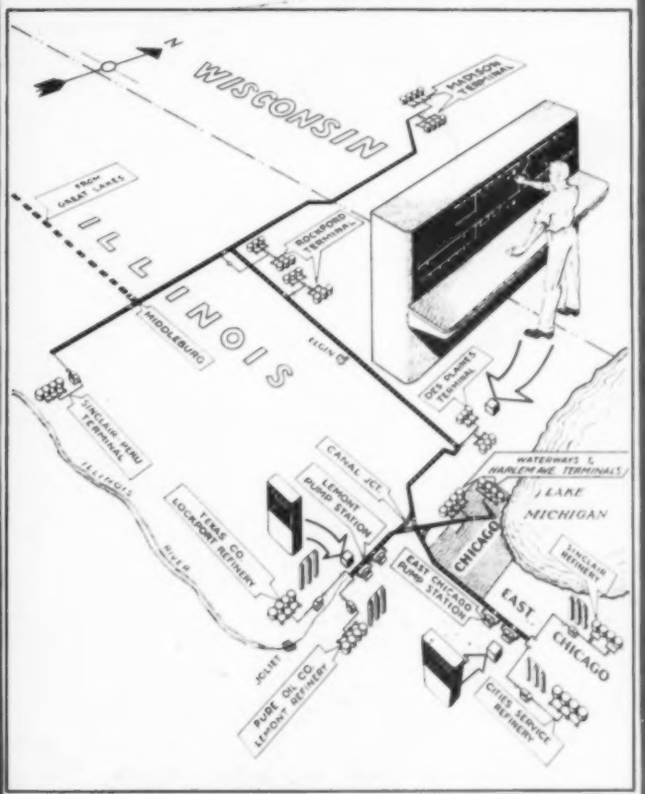
SIMPLE AUTOMATIC CONTROLS PAY OFF



Simplified control is the keynote in the design of the Badger pipe line. Instruments and heavy equipment are interchangeable from station to station ..... Page 16

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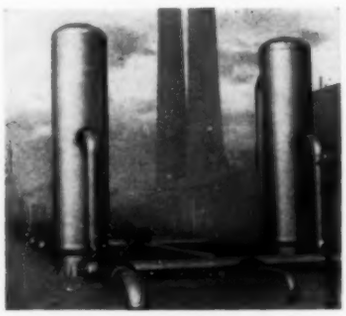
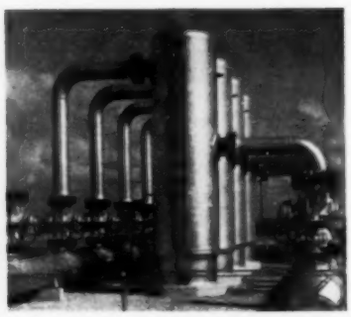


Two Peerless 48 x 19 Scrubbers, each handling 50 million CFPD at 250 PSI on inlet of a power plant in South Texas.



FOUR Peerless 60" x 19" Scrubbers handling a total of 132,000,000 CFPD at 600 PSIG, working pressure. Located at new pipeline compressor station.

Shown above is a cutaway of a Peerless Vertical Scrubber. This illustration indicates the path followed by the gas stream as it passes through the scrubber.

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PIPE LINE INDUSTRY

CONTENTS and Quick Review

February, 1956 Vol. 4, No. 2

To help you put first things first, scan these time-saving digests, checking ☑ those you want to read first.

It's a Snap

Wherever there is a pipe line, there usually is a pipe line hint or two—and all our editors have to have is the basic idea and a good photograph and an extra $10 will be in the mails to you. To test your camera's earning power today, take a simple snapshot of a new How-To-Do-It item or installation you have found, jot down the basic ideas for building it or putting it together, and send it all to PIPE LINE INDUSTRY, P. O. Box 2608, Houston 1, Texas. For each How-To-Do-It idea the editors accept, you will receive $10.

Editorial Index . . .

Your editorial index of all PIPE LINE INDUSTRY articles published in 1955 is available in convenient pamphlet form. And it's free for the asking. Use the Readers' Service blue postcard, last page of this issue, to order yours. Just check the space indicated and drop the postage-paid card in the mail.

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Simple Automatic Controls Pay Off

☐ Simplified control was the keynote in the design of the new Badger pipe line. Instruments as well as heavy equipment are interchangeable from station to station.

By Joe M. Purvine ..... Page 16

How to Calculate Pipe Stresses (Part 1)

☐ This new tabulation method can save you time without sacrificing accuracy in calculating stresses in three-dimensional piping systems. The first part of this three-part series tells how to use the tabular method.

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Trend Toward Larger Electrical Drives

☐ What is the trend in pipe line electrical drives? Generally it is toward larger drives. More reliable motors are making this possible.

By D. N. High and F. C. Osterland ..... Page 26

Discounted Cash Flow Method

☐ What are the factors to consider in making a capital outlay decision? Are your present evaluation methods meeting both current and future requirements? This analysis of one company's policies and methods can help you develop a wise capital outlay program.

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Use Your Engineers to Meet the 'Shortage'

☐ Here's a suggestion that perhaps many companies which speak of the engineering "shortage" have all the engineers they need. The author suggests that engineers are being used in jobs that could be filled by less technical men.

By Emmett G. Jackson ..... Page 34

Arctic Pipelining on the Equator

☐ Moving crude from the Lirik field in Sumatra led to some unusual means of transportation. Stanvac engineers considered them all and came up with what appears to be the answer for moving the 105° F pour point crude.

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Report on Two-Phase Vertical Flow

☐ Making pressure drop calculations where the system involves two-phase flow is a hard job. Here are some experimentation results that will make clearer the mechanics involved.

By W. C. Galegar, W. B. Stovall and R. L. Huntington ..... Page 38

What Is the Economical Size of Conductors?

☐ You don't have to be an electrical engineer to compute the economical line size for electrical installations. Use this simple formula.

By Herbert Argintar ..... Page 44

PIPE LINE INDUSTRY published every month. Entered as second class mail matter July 9, 1954, at the post office at Houston, Texas, under the act of March 3, 1879.

Critical Problems Face Oil Men

An extremely critical year faces the oil industry of the U. S. Several very important matters are likely to be settled. They are of such far-reaching significance that the industry's operations for years to come are to be vitally affected.

The problems ahead will be of a political or legislative nature, rather than economic. So far as economic prospects are concerned, the industry's outlook is bright. Higher consumption is anticipated, and this will require that increased volume be produced, transported and refined.

Nevertheless, there are several problems which oil men must meet squarely and with resolution in 1956.

•

Oil imports is one of the important problems that needs to be settled in some fashion. After years of arguing within the industry as to what should be done about imports and how it should be done, it is probable that some definite course of action will be decided upon during the next 12 months. If oil companies do not achieve some voluntary solution, it is likely that Director of the Office of Defense Mobilization Arthur Fleming will use his powers to impose government restrictions.

The latter would bring another phase of the industry under government regulation. This should be avoided if at all possible. Each additional operation regulated by the government brings the industry closer to complete government control.

Here is a case where warnings by Mobilizer Fleming gives oil companies a choice of doing something themselves or having the government do it for them. The answer will be forthcoming in 1956, and likely will establish a precedent that will have a vital influence for years to come.

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Whether natural gas prices received by producers are to be government regulated is another vital problem that will be decided in 1956. Unless the present situation is corrected, the industry will be permanently handicapped and a long, long step will be taken toward national Socialism and death of free enterprise.

•

The depletion allowance is still another vital long-range matter that may become a problem in 1956. Efforts are likely to be made to reduce the 27½ percent income tax allowance now given the producing branch of the industry.

Nothing could be of greater importance to the industry's future. This long established right must be protected with all the resources of the industry. Every oil man should be anxious to do all that he can to explain this need to the public and members of Congress. Otherwise, the industry may be seriously and permanently injured—and what hurts industry is dangerous to the American people, whether they be laborers or capitalists.

•

To obtain relief on these matters through legislative routes is going to take strenuous effort on the part of far more oil men than are now actively engaged in explaining the dangers to members of Congress and the public. Time is short and rapidly running out, yet an entirely too large a segment of the industry is not giving these matters sufficient attention. Much larger scale and more forcible efforts must become engaged in these fights to succeed in correcting some of the most dangerous situations ever to confront the industry. This will require the cooperation of more oil men.

Warren L. Baker

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Personnel Changes Announced By Gulf Publishing Company

A. L. Burns, who recently observed his thirty-fifth anniversary with Gulf Publishing Company, has relinquished his duties as vice president and general manager of the company to devote full time to Gulf Printing Company. Burns has served as president of Gulf Printing Company for the past two years.

Tom W. Nelson, vice president of Gulf Publishing Company, has been named executive vice president and general manager of the company. **Robert M. deSombre,** director of Gulf Publishing Company's Circulation department, has been appointed assistant general manager. He also was elected a vice president of the company.

Douglas S. Craig, a veteran member of the GPC Advertising department, was named advertising sales manager for PIPE LINE INDUSTRY, WORLD OIL and THE COMPOSITE CATALOG.

Ray L. Dudley is president of Gulf Publishing Company and Chairman of the Board of Gulf Printing Company. Burns will continue as a member of the board of directors of Gulf Publishing Company and serve on the company Advisory Committee.

Gulf Publishing Company publishes PIPE LINE INDUSTRY, WORLD OIL, PETROLEUM REFINER, THE COMPOSITE CATALOG for the drilling-producing industry, and THE REFINERY CATALOG for the refining-natural gasoline-petrochemical industry.

Judah Is Named Editor Of Pipe Line Industry

Melvin A. Judah, an associate editor for the past year, has been named editor of PIPE LINE INDUSTRY.

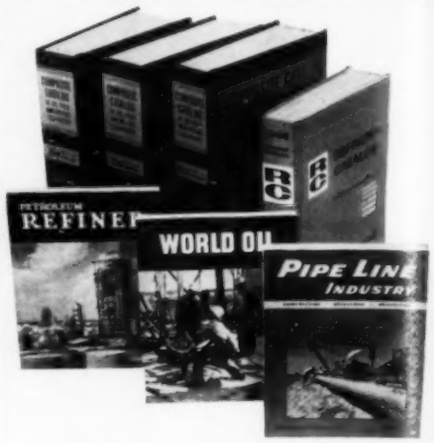
Melvin A. Judah

A graduate of Texas A. & M. College, Judah served on the staff of the National Association of Corrosion Engineers for four years preparing field reports on pipe line corrosion studies. He was recalled to active duty with the U. S. Navy and served two tours with the Seventh Fleet off Korea. Judah formerly was assistant editor in the Houston offices of *Chemical and Engineering News, Industrial and Engineering Chemistry* and the *Journal of Agricultural and Food Chemistry.*

Have you ordered your Editorial Index?

The complete editorial index covering all issues of PIPE LINE INDUSTRY published during 1955 has been prepared and bound in convenient pamphlet form. It will be sent free to all subscribers requesting copies. Address your orders to Librarian, Gulf Publishing Company, Box 2608, Houston 1, Texas, or use the convenient Readers' Service Postcard on the last page of this issue. Just check the space indicated. Supplies are limited.

PIPE LINE INDUSTRY



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R. M. deSombbre, Circulation Manager, P. O. Box 2608, Houston, Texas, U. S. A.

Single copies 50 cents (except special issues). Double price for single copies more than a year old. Subscription price: domestic and foreign $2 a year; 2 years, $3; 3 years, $4. Subscription restricted to those engaged in the pipe line branch of the oil and gas industry, or the manufacturing and distribution of pipe line equipment.

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"THE NEW NO. **583** IS THE ANSWER TO A PIPELAYER'S DREAM WHEN IT COMES TO CRADLING **BIG INCH"**

T. E. Davis, Superintendent
Williams Brothers Company

ONE of the first orders for the all-new CAT* No. 583 Pipelayer came from Williams Brothers Company, Tulsa, Oklahoma. A unit was put to work immediately in Virginia on a section of the 30-inch gas pipeline being built from Texas to New York for Transcontinental Gas Pipeline Corp. of Houston, Texas.

After watching the No. 583 at work beside other Caterpillar-built machines, Superintendent T. E. Davis commented:

"I've been 26 years with Williams Brothers in pipeline work using Caterpillar-built equipment. In my opinion, there is no better equipment made. And the new No. 583 is the answer to a pipelayer's dream when it comes to cradling big inch."

Mr. Davis particularly liked the ground clearance and counterweights on the new unit—the first pipelayer which is *all pipelayer and not a tractor attachment.*

The No. 583 has good stability and balance to obtain the best ground pressures on each track. In addition the counterweights retract well over track to give maximum right-of-way clearance. And they stay put in retracted position without hydraulic pressure.

The No. 583, *with a lifting capacity of 130,000 pounds,* is the most efficient pipelayer in history. Caterpillar engineers worked closely with pipeline people in designing it, so it answers the problems *you* wanted licked. No detail has been overlooked.

It has so many new developments, it must be seen personally to be appreciated. A few of these features are: the live drive which supplies steady power to the boom and load lines independent of the flywheel clutch, torque converter drive which permits crawl speeds necessary for lowering in, 21-inch ground clearance and others. So see the No. 583 soon. Your Caterpillar Dealer will show you how the *first unit-built* pipelayer can boost profits on your jobs.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

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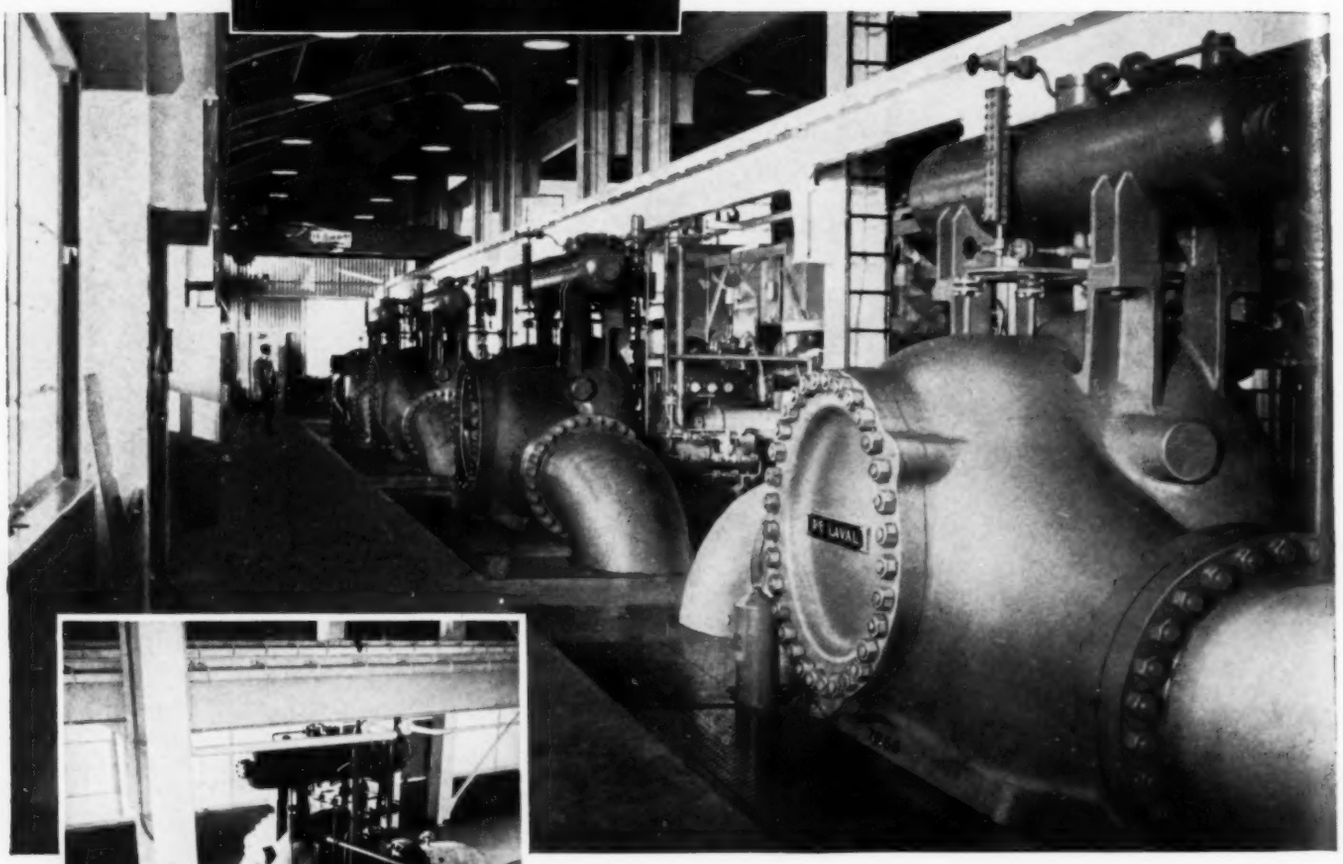
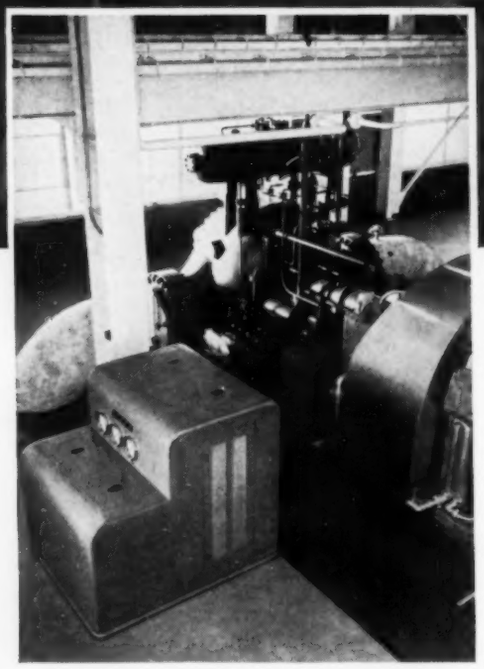
MODERN HEAVY-DUTY PIPELAYING EQUIPMENT

FOUR DE LAVAL CENTRIFUGAL COMPRESSORS *in Tescott, Kansas station of Northern Natural Gas*





For easy installation, De Laval pipeline compressors are designed in two packages: (1) The machine plus the emergency seal tank, (2) The auxiliary console which contains the filters, pumps, coolers and other accessories.

Here's more proof of the efficiency and dependability of De Laval centrifugal compressors for high pressure gas transmission. This Tescott, Kansas station of the Northern Natural Gas Co. has four De Laval centrifugal compressors in series.

The station flow is 930 M²SCFD, station inlet pressure 477 psig and discharge pressure 745 psig. *By changing the impeller and a few minor parts, these units can handle 1,100 to 1,200 M²SCFD.* Three identical De Laval compressors are on the job in the Macksville, Kansas station of Northern Natural.

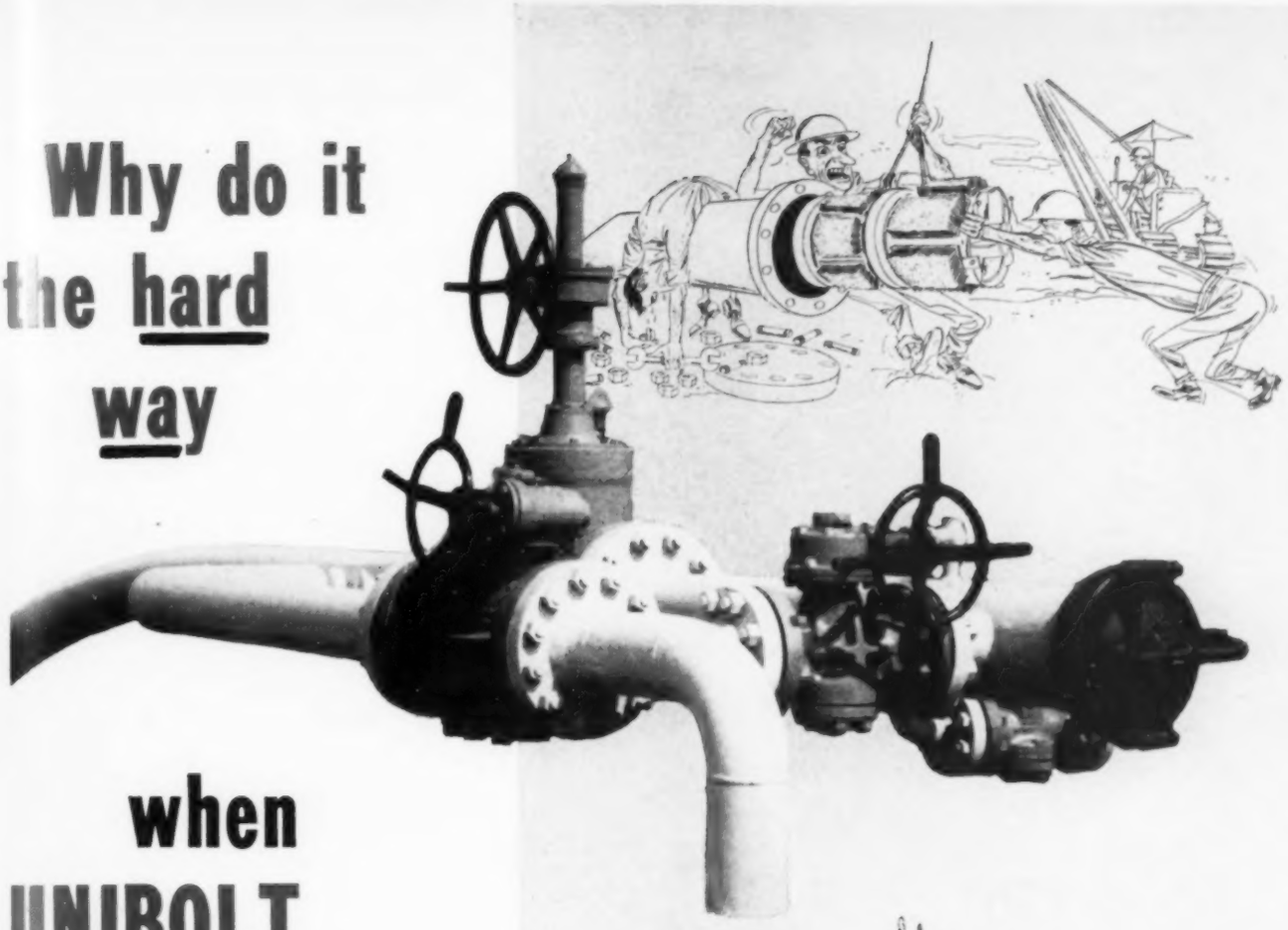
De Laval centrifugal compressors offer important engineering features. • Pressure contact shaft seal eliminates gas leakage. • Construction is heavy and rigid throughout. • Units have high load carrying capacity. De Laval units, totaling more than 200,000 hp, are now in operation on major pipelines.

DE LAVAL *Centrifugal Compressors*

DE LAVAL STEAM TURBINE COMPANY
884 Nottingham Way, Trenton 2, New Jersey

DL309

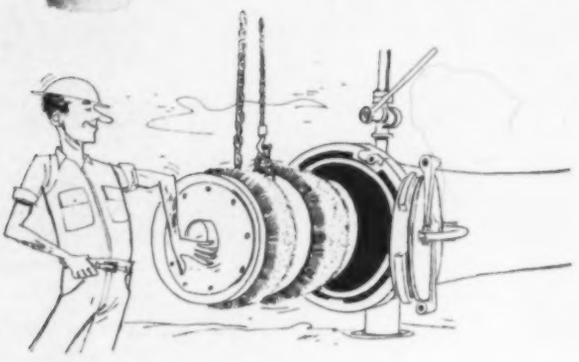
Why do it the hard way



when UNIBOLT Scraper Traps

(with oversize barrel)

make pigging so easy!



Unibolt Scraper Trap Closures are the most convenient, most practical means for blanking off a line so that pigs may be easily inserted and removed from the trap. The scraper barrel being slightly larger than the pipe itself, the pig is easily inserted or removed. It is no longer necessary to "fight" the pig in and out of the trap. Release two bolts and the blanking plug swings open on a sturdy hinge. Swing the trap shut, tighten the bolts, and that's all. Let the pumps do the hard work. No heavy blind flanges to lift on or off. No multiple bolts to release and make up. Nothing to fall on the workmen. No leaky threads. An oil-resistant gasket seals automatically . . . seldom needs replacing.

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THESE MIDWEST "LONG TANGENT" ELBOWS SAVED $4121 IN PIPE

MIDWEST "LONG TANGENT" ELBOWS COST NO MORE THAN OTHER ELBOWS

Here are 1227 Midwest "Long Tangent" Elbows (12", 14" and 16" standard weight) ready for shipment to a chemical plant. Each Midwest "Long Tangent" Elbow has a straight section on each end equal in length to ¼ the nominal pipe size. Thus a 12" elbow saves 6" of 12" pipe while a 16" elbow saves 8" of 16" pipe. It doesn't take long to save a lot of pipe and a lot of money . . . in this instance $4121.

But saving pipe is not the only advantage of Midwest "Long Tangent" Elbows. They often eliminate short nipples and their extra welds . . . save time and money in lining up and clamping pipe and fittings . . . slip-on flanges are more easily applied. For all the facts, write for Catalog 54.

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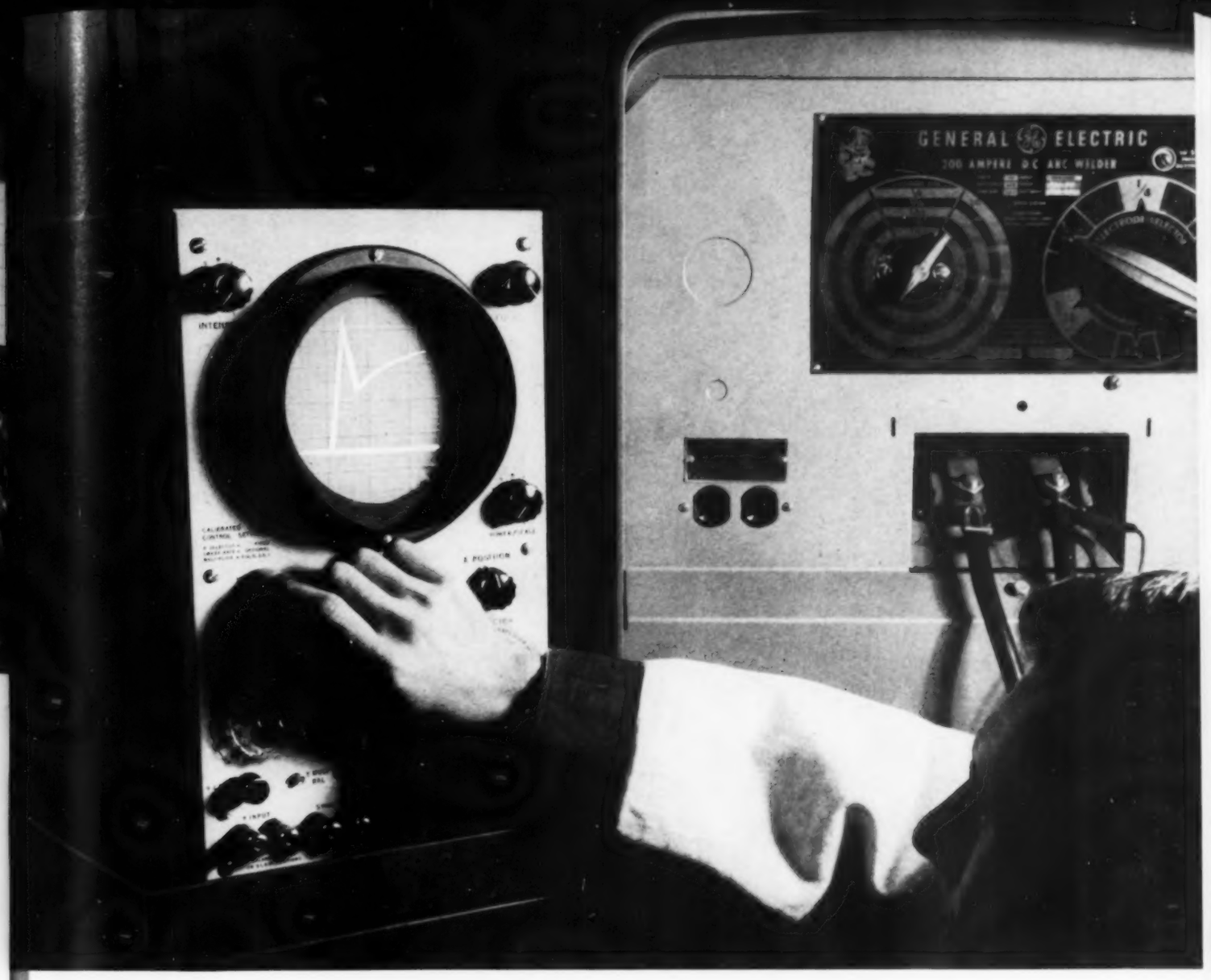


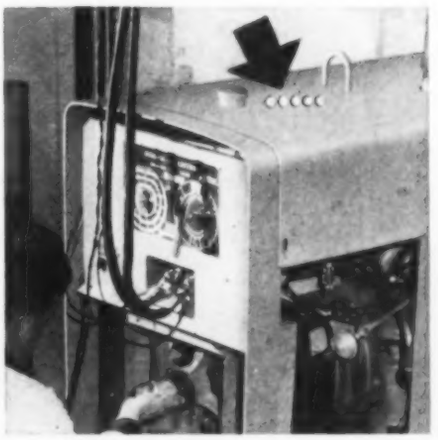
G.E.'S NEW ENGINE-DRIVE WELDER GIVES YOU . . .

Steady Welding Output—at Full Load; Improves Weld Quality, Costs Less Too

If you're using more than a 200-amp engine-drive welder for light to medium-heavy construction, you may be losing money. You may be paying for inefficiency—compensating for excessive loss of amperage and arc heat when operating at full load for sustained periods.

Now, with G.E.'s new 200-amp engine-drive welder, it's not necessary to buy more expensive, higher rated machines for pipeline, light construction, or job-shop work. This field-tested welder gives you steady output and 100% arc stability, hour-after-hour, even when operated ***above*** full load.

Test this powerful new welder yourself, and see the many advanced design features—new slow-down control, extra-rugged construction, and many others. Contact your nearby G-E Welding Distributor today. He's listed in the yellow pages of your phone book. Section 714-3, General Electric Co., Schenectady 5, New York.



EXTRA-STURDY construction is shown in this demonstration. Five nickels stand on edge while welder is operated at full load.

GENERAL ELECTRIC

Robt. K. Little
Midland, Texas

Chandler Markell
Tulsa, Oklahoma

Lloyd A. Brudvig
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These men are ready to serve you . . .

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IN THE OIL COUNTRY

Nothing can beat "on the spot" service, particularly when you know it is specialized. These men are Youngstown Field Engineers—specialists in Oil Country Tubular Goods and drilling operations.

Strategically located to best serve the oil fields, they actually live with your problems.

Their job is to help you secure **all** the advantages built into Youngstown Oil Country Tubular Goods.

When you need tubular engineering service contact your nearest Youngstown Sales Office.

You'll find Youngstown's Field Engineering Service as near as your telephone.

YOUNGSTOWN DRILL PIPE
MADE FOR OIL MEN BY PIPE MEN

QUALITY V YOUNGSTOWN SERVICE

Youngstown DRILL PIPE

THE YOUNGSTOWN SHEET AND TUBE COMPANY *Manufacturers of Carbon, Alloy and Yoloy Steel*

General Offices Youngstown, Ohio District Sales Offices in Principal Cities.

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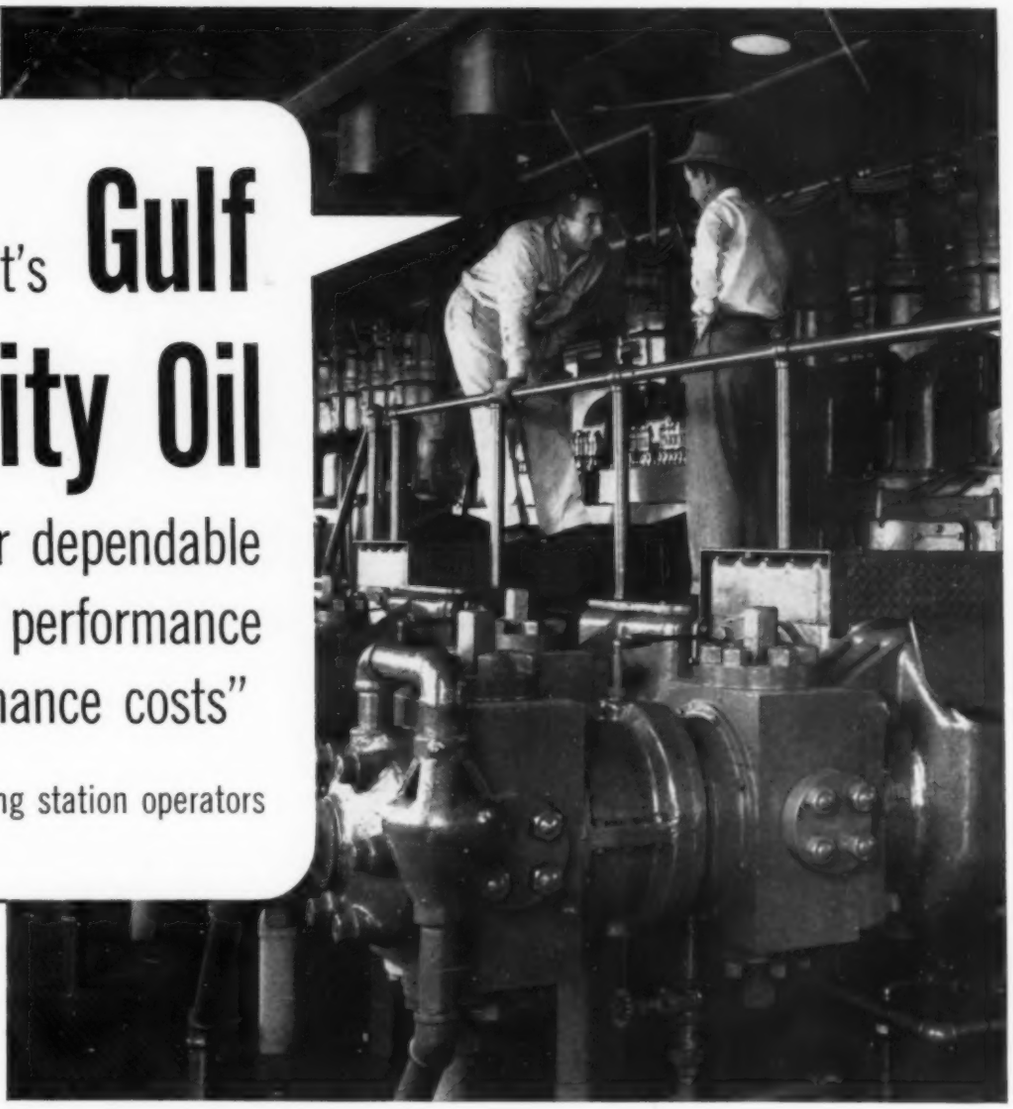
For more data on advertised products, use Readers' Service Cards, last page.

"It's **Gulf**

Security Oil

for dependable
gas compressor performance
and low maintenance costs"

say pumping station operators



Smooth, continuous operation is a must for these units in service at a South Texas gas compressor plant. They are responsible for the steady flow of essential natural gas through pipe lines to homes and industries as far north as Detroit and New York. Gulf Security Oil provides the sure, effective protection needed for cylinders and bearings in both engines and compressors.

You can depend on Gulf Security Oil to provide the proper lubrication that is so important to vital compressor units if operating troubles are to be prevented and maintenance costs kept low.

Gulf Security Oil has a record of outstanding performance in scores of gas transmission plants. After years of operation with this quality oil, the cylinders and piston rings of both the compressors and power assemblies show negligible wear. And few carbon deposits have formed on power cylinder ports and pistons.

If you are installing new compressor units, or feel that you're not getting the most effective lubrication possible for your present units, it will certainly pay you to try Gulf Security Oil. Contact your nearest Gulf Office and have a Gulf Sales Engineer call.

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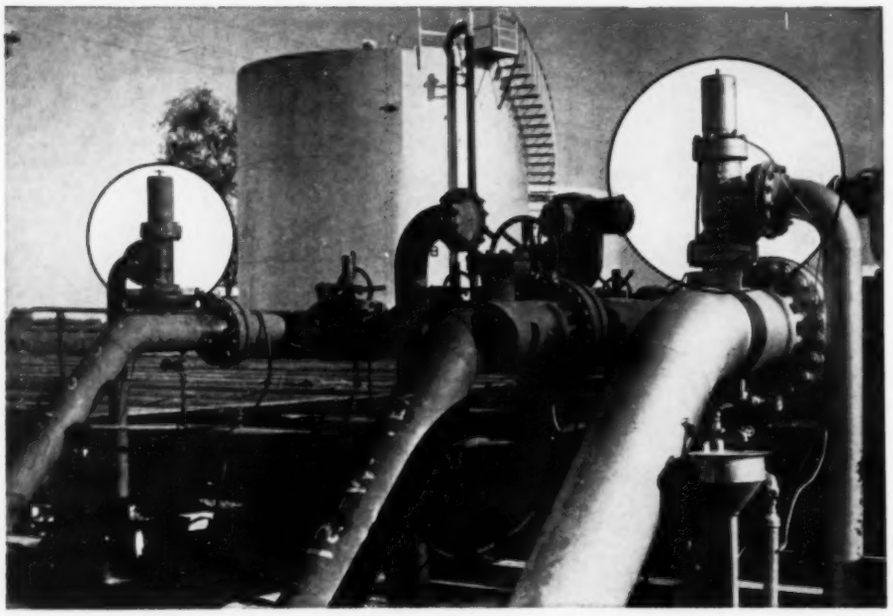

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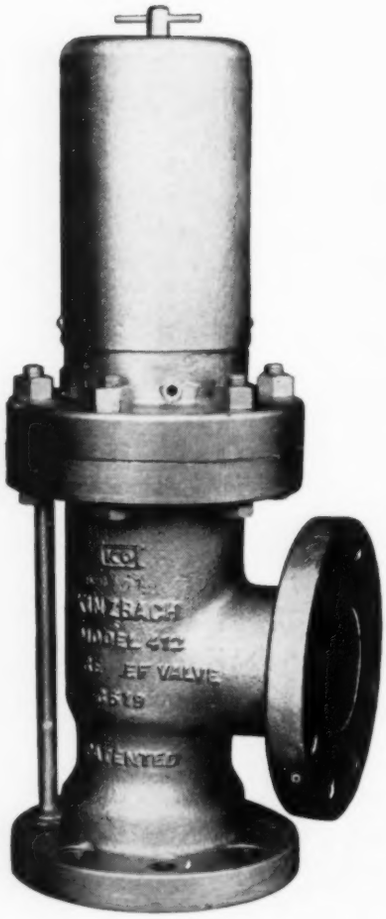

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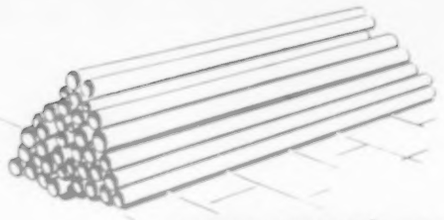
WHO'S MEETING WHERE

1956 JAN. 30–Feb. 3	American Institute of Electrical Engineers, Hotel Statler, New York.
FEB. 1–3	Technological Institute of Monterrey and National Association of Corrosion Engineers USA, Short Course on Corrosion, Monterrey.
15–17	American Society of Civil Engineers Construction Division, Committee on Pipe Lines, Baker Hotel, Dallas.
15–17	National Association of Corrosion Engineers, Tulsa Section, Corrosion Short Course, Mayo Hotel, Tulsa.
19–23	American Institute of Mining and Metallurgical Engineers, Hotel Statler, New York.
19–25	National Engineers' Week.
MAR. 12–16	National Association of Corrosion Engineers, Hotel Statler, New York.
19–21	Mid-West Gas Association, Hotel Fontenelle, Omaha, Nebr.
22–23	New England Gas Association, Annual Meeting, Hotel Statler, Boston.
APRIL 1–8	National Oil and Uranium Exposition, 48th District Agricultural Association Building, Los Angeles.
3–5	Corrosion Control Short Course, The University of Oklahoma, Norman, Okla.
14–15	Southern Gas Association, Conference on Use of Electronic Computers by Engineering Personnel, Hilton Hotel, El Paso.
17–19	Southwestern Gas Measurement Short Course, University of Oklahoma, Norman.
18–20	Conference on Marine Corrosion and Fouling Problems, University of California Engineering Extension, La Jolla Campus.
19–20	Indiana Gas Association, French Lick Springs Hotel, French Lick, Ind.
23–25	Southern Gas Association, Annual Convention, Dallas.
30–May 4	API Safety & Fire Protection Midyear Meeting, Warwick Hotel, Phliadelphia.
MAY 7–10	AGA Distribution, Motor Vehicles and Corrosion Conference, Congress Hotel, Chicago.
10–11	AGA Gas Supply, Transmission and Storage Conference, Conrad Hilton Hotel, Chicago.
13–16	API Division of Transportation, Shamrock-Hilton, Houston.
22–24	Pennsylvania Gas Association, Pocono Manor Inn, Pocono Manor, Penn.
24–25	Natural Gas & Petroleum Association of Canada—Sheraton Brock Hotel, Niagara Falls, Ont., Canada.
JUNE 24–27	Canadian Gas Association, Manoir Richelieu, Murray Bay, Quebec.
25–26	Michigan Gas Association, Grand Hotel, Mackinac Island, Mich.



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	.188"	8.64
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	.237"	10.79
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	.188"	12.89
	.219"	14.97
	.250"	17.02
	.280"	18.97

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On the Badger Line . . .

Simple Automatic Controls Pay Off

A single basic pattern used for constructing and equipping each station. Instruments and heavy equipment are interchangeable.

By JOE M. PURVINE
Cities Service Oil Company (Delaware), Bartlesville

BADGER PIPE LINE consists not of one single pipe line but of three separate lines joined together at strategic locations to provide the most flexible petroleum products transportation and delivery system in operation today. The system is jointly owned by Cities Service Oil Company (Delaware), The Pure Oil Company and Sinclair Pipe Line Company.

One line originates at the East Chicago, Ind., pump station and terminates at the Madison, Wis., meter station. This line, consisting of 175 miles of 12-inch pipe, daylights at the Canal Junction crossover and the Des Plaines and Rockford meter stations on its route to Madison.

A second line originates at the Lemont, Ill., pump station, cross-ties to the East Chicago-Madison line at Canal Junction, and terminates at the Harlem Avenue meter station. This line is made up of about 18 miles of 10-inch pipe.

The third line, consisting of 67 miles of 8-inch pipe, begins at the Peru, Ill., pump station, passes through a meter station at Middlebury, Ill., and terminates at the Rockford meter station. This line ties to the East Chicago-Madison line at the Rockford meter station.

The pump stations at East Chicago and Lemont, each of which is powered by two 300-horsepower, 2300 volt, 3600 rpm, explosion-proof motors, are fully equipped with electrical auxiliary equipment and supervisory equipment to facilitate their control remotely. The pump station at Peru is powered by two 250-hp, 2300 volt, 3600 rpm, vertical, explosion-proof motors. Although the Peru station is electric, it is not equipped for remote control. All meter stations are outfitted with electrical equipment which is controlled locally by push-button operation.

Switchgear for the East Chicago and Lemont pump stations is of outdoor, heavy duty, metal-clad construction. The gear for each station consists of an incoming line compartment equipped with an oil circuit breaker; two motor-starting compartments, also equipped with oil circuit breakers; two auxiliary compartments, one of which houses the magnetic starting equipment for the motor-operated valves, and one which contains the tripping batteries, battery charger, etc.

Switchgear for each meter station, consisting of magnetic starters for motor-operated valves, etc., is of indoor construction. Each central control cabinet affords push-button operation from its front. The gear for the Peru pump station is of metal-clad construction and houses an incoming line air circuit breaker, two air circuit breaker motor starters and an auxiliary compartment.

Although large in scope, operation of the system basically is simple and uncomplicated because simplicity of control was designed into the system. Controlwise, simplicity dictates that the number of functions to be performed by human operators be kept to a minimum. By using the basic control circuitry of a sequentially-operated unit and triggering that circuitry by the manipulation of a single lever, simple control methods were achieved.

Supervisory equipment installed in the Badger system utilizes the time-code principle. Physically, the control system consists of a master control panel in the dispatcher's office at Des Plaines; similar control panels at the East Chicago and Lemont pump stations; and field equipment cabinets at Canal Junction and Cities Service East Chicago refinery. Due to close proximity, control of the Sinclair refinery booster pump and associated valves is obtained through equipment at the East Chicago pump station.

Though operation of the system normally is accomplished remotely from Des Plaines, each pump station control panel and each field cabinet has provisions for local control of its own station equipment. Local control of the pump stations may be either by the supervisory equipment or by push-buttons at the controlled equipment. At the Cities Service refinery and Canal Junction, however, local control is possible only by use of push-buttons at the equipment.

The master control panel at Des Plaines is equipped with a graphic mimic which portrays the entire Badger system. The panels at the Lemont and East Chicago pump stations also exhibit a graphic. Each of these mimics, however, exhibits only the particular part of the system which can be controlled from the pump station console. Field equipment cabinets

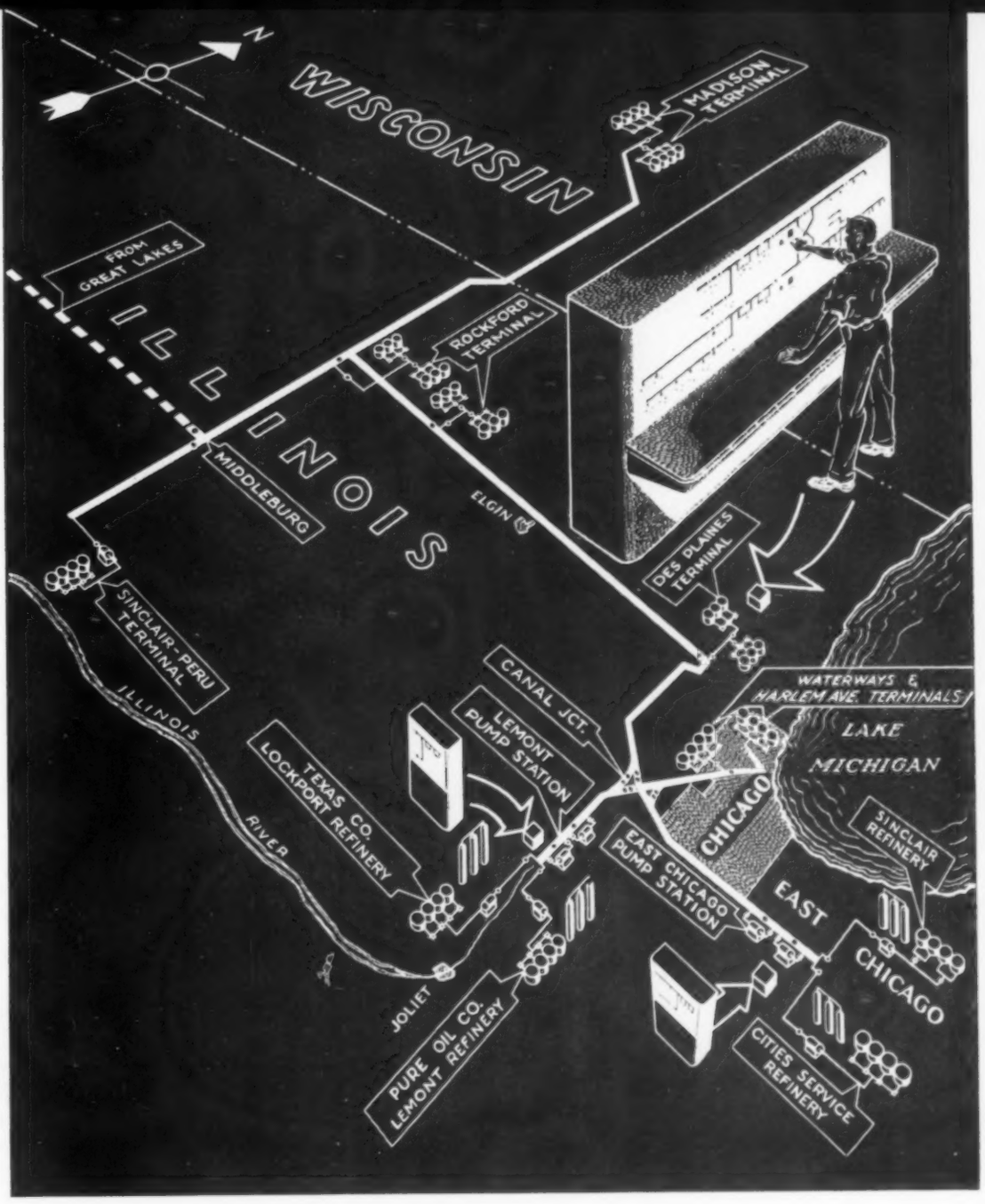


FIGURE 1—Diagrammatic layout of Badger pipe line system. Chief dispatcher's office is at Des Plaines, Ill. Local offices are at Lemont and East Chicago pump stations.

at Canal Junction and the Cities Service refinery do not present a graphic. In fact, the only control lever on either cabinet is one which, by operation, transfers control from remote to local, thereby making local control possible by operating push-buttons at the controlled equipment.

Control levers on the control panel, located relative to their respective units and properly identified, are manipulated for control of the units. Operation of a control lever automatically initiates operation of the code unit which generates a code by alternately applying to and removing from the wire line a direct current source. The direct current pulses applied to the line are transmitted to all field stations, each of which has a line relay which follows the code and a code unit which interprets the code. At the field station which has the assignment for a particular code, the appropriate control relay is energized, causing the field equipment it controls to operate accordingly.

Interlocking code features within the units force the coding unit at the control point automatically to take control of the system should both the control point unit and field unit attempt to code simultaneously.

To demonstrate the simplicity of operation, the simulated delivery of a product into the Badger system from Cities Service refinery should suffice. This particular operation actually requires more manipulations than does any other control function throughout the system.

On the master control panel at Des Plaines, the dispatcher determines which of the six alloted tanks at the Cities Service refinery contains the product to be delivered into the line. He then turns and depresses the associated lever which automatically establishes the code transmission to open the selected motor-operated tank valve. When the tank valve, which also doubles as the suction valve for the refinery booster unit, is full open, a limit switch closes the control circuit to start the booster pump motor. Simultaneously, a time-delay relay is energized which, when timed out, will start the transmission of a code from the field equipment to the pump station equipment to open the East Chicago pump station block valve. The operator sets up the opening of this valve by turning and depressing the

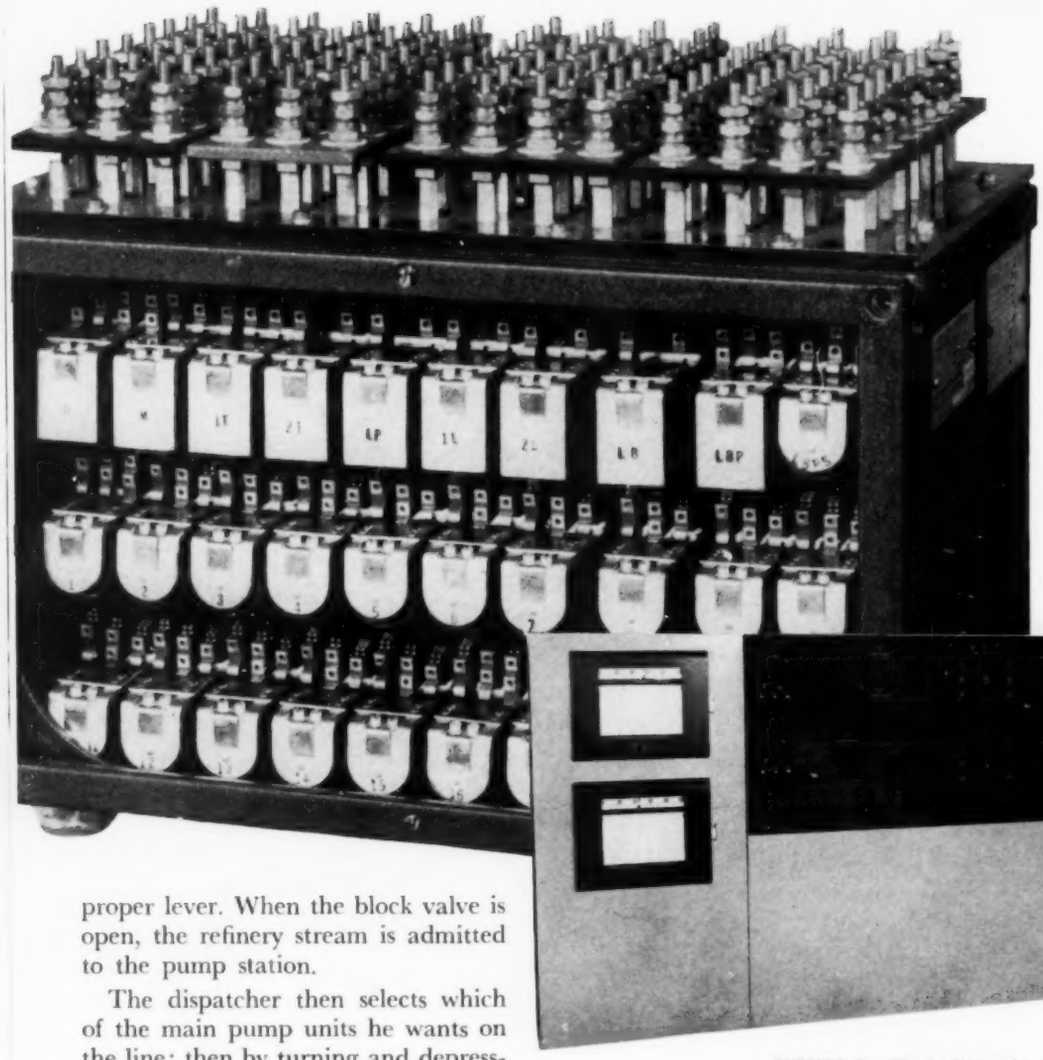


FIGURE 2—A typical code unit. Two types of relays are used. Square armature relays (top row) are used for timing; the round-type (lower rows) are used in counting chain and for all interpreting functions.

FIGURE 3—Chief dispatcher's control console which shows layout of Badger line. Arrows show direction of flow; indicating lights show other conditions. Impulse duration telemeter receivers are at left.

proper lever. When the block valve is open, the refinery stream is admitted to the pump station.

The dispatcher then selects which of the main pump units he wants on the line; then by turning and depressing the associated control lever, he initiates opening of the proper suction valve. A pressure switch, closed when there is sufficient station suction pressure, in series with a limit switch, closed when the suction valve is full-open, energizes the control circuit to start the selected pump unit. When the unit breaker pulls in, the motor-operated discharge valve is energized to open.

Hence, the manipulation of one control lever for the refinery booster unit, one to position the block valve, and one for the main pump station unit is all that is required to accomplish the desired operation. Should the dispatcher require maximum station throughput, he needs only to operate an additional lever to bring the second unit on the line. To shut the station in, it is necessary only to initiate closing of the discharge valves, and the station will go down in the sequence of discharge valve close, pump motor off, and suction valve close.

The control panels, in addition to providing a means to operate the system, also provide visual indications which enable the operators to ascertain at a glance the status of any equipment. When any pump station or refinery equipment, whose operation is being indicated back to Des Plaines, changes position and operates its contacts, a code automatically is initiated. The same code unit which interpreted the control code generates an indication code containing the information of the change in position of the equipment. This code is received at the controlling station, interpreted, and causes the appropriate indication relay to change the lamp indication on the control panel.

The graphic display includes flow arrows to show actual flow through the various stations and the system. These arrows are illuminated automatically in agreement with the code information received from the field. Lamps corresponding to lever positions show actual functioning of equipment in the field, determined by information automatically transmitted from the field. In addition, small target-type lamps show each unit in the process of sequencing, when control and indication codes are in progress, and when there is a failure of the transmission system.

In addition to the automatic indication system, the dispatcher has a manually-operated record-keeping display which is an extension of the automatic board. This panel consists of a graphic display of all delivery valves at Des Plaines, Harlem Avenue, Rockford and Madison meter stations. This display has a toggle switch associated with each valve shown, and each valve has two indication lamps to show either open or closed position. Operation of the toggle switch from one position to the other will cause one of the indication lamps to light along with the appropriate flow arrows in the piping mimic.

At Canal Junction, where the East

Chicago-Madison and Lemont-Harlem lines are manifolded, there are eight motor-operated gate valves. These valves are piped up in a double valve arrangement of four sets of two valves each. This manifold provides the flexibility needed to divert products from the Lemont-Harlem line to the East Chicago-Madison line, and vice versa.

Each set of two valves operates simultaneously from one transmitted code. In addition, each set of valves in the main lines are interlocked by local wiring with the set of valves in the by-pass. This arrangement prevents splitting the stream in either of the lines and reduces to a minimum the possibility of turning both streams into the same line. The local wiring interlock is backed up by a relay interlock in the supervisory equipment.

Incorporated in control of the pump stations are various protective and shut-down devices. Motor bearings and windings, pump bearings and pump cases are protected against overtemperature operation by thermocouple-actuated relay shut-down systems. A sensitive relay receives the intelligence from the thermocouple and, in turn, operates a power relay which performs the shut-down function. Pressure switches protect against low suction pressure, but not against high discharge pressure. When pumping to Rockford or Madison from either of the pump stations, the operating point is back on the flat portion of the pump curve where there is insufficient differential. Application of a high discharge pressure switch under this condition might cause false shutdowns.

Each pump station and meter station is equipped with an instrument panel in the control room. The pump station instrument panels contain circular chart recorders for suction, intermediate and discharge pressures; a circular chart flow recorder and digital totalizer; a circular chart temperature recorder; differential pressure indicating gages to disclose the pressure drop across the hay tanks and strainers; and a strip chart recorder which is used in conjunction with the interface detector, or product indicator, unit. Each meter station panel contains all the instruments listed above except the pressure recorders.

In each control room there is also a selsyn driven print-out head and totalizer. This unit is driven by a selsyn transmitter located near the meters in the equipment area. Each positive displacement meter feeds a combinator unit which drives the selsyn unit. Also found on the combinator at each pump station is a mechanical-electrical transmitter which drives the synchronous movement in the flow recorder.

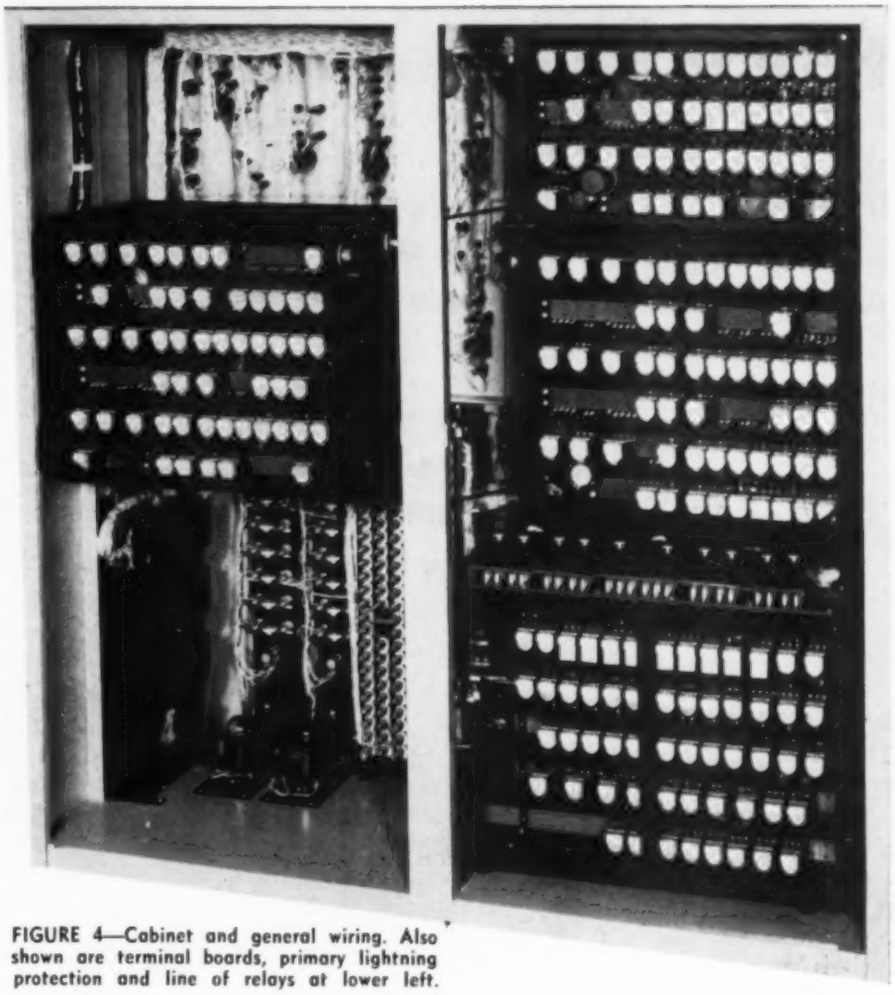


FIGURE 4—Cabinet and general wiring. Also shown are terminal boards, primary lightning protection and line of relays at lower left.

One instrument used in the Badger system not generally found in pipe line operations across the country is the particular interface detector installed at each station. This unit electronically measures on a relative basis the dielectric constant of a liquid hydrocarbon.

In operation, a radio-frequency energy is transmitted to a capacitance measuring circuit. This energy is impressed across two capacitors in series, which are so proportioned that the greater part of the voltage drop is across the first capacitor. Then by a special diode voltmeter circuit, the drop across the second capacitor is measured. This drop is the actual voltage used to determine the product.

At Canal Junction, the two product indicator recorders are equipped with retransmitting slide-wires which input to a telemetering unit. This intelligence then is transmitted over leased wire facilities to receiving instruments located in the dispatcher's office.

All Badger stations readily are available to the dispatcher for any control or communication function. In addition to ordinary local and toll telephone service, the Badger system supports a closed teletype network over leased wire line. Each pump station and meter station has a teletype machine in its control room. For control of the pump stations, the master and remote supervisory equipments are tied together by leased wire circuits.

Maintenance of equipment and instruments is made easier by the fact that one basic pattern was used for construction and equipping of each station. Instruments are interchangeable from one station to another; heavier equipment also is duplicated. Operating personnel experience no difficulty in performing their classified duties should they be called upon to fill in at a station other than their own. —**The End**

How to Calculate Pipe Stresses

This new method can save time in calculating three dimensional system pipe stresses. This is the first in a three-part series.

Part 1. How to Use the Tabular Method
Part 2. Systems with Different Moments of Inertia
Part 3. How to Handle Elbows and Bends

By K. HAO HSIAO
The Ralph M. Parsons Company, Los Angeles

PIPING SYSTEMS, as part of the equipment of modern pipe line stations and refineries, are subjected to high temperatures, pressures and corrosive conditions. Thus, in order to prevent failure of equipment and withstand the great stresses due to thermal expansion, piping stress analysis has become increasingly important.

Piping stress calculation by conventional methods is a tedious process, prone to error: the analyst must face the monotony and labor of computing many rows and tables of figures, and go through the mechanical routine of solving simultaneous equations for each piping system. A "fatal" error in signs, which would require complete repetition of calculations must be avoided.

There is a great need for a time-saving method of calculation.

The tabulation method presented here saves hours without sacrificing accuracy in piping stress calculations. The proportion of simplification increases with the number of pipe branches in a system. It also eliminates the necessity of locating the centroidal axes of a system and the centroids, ends and joints of its different branches with respect to these axes in three perpendicular planes (in addition to an isometric view), for calculations of bending moments and torques about these points. The analyst requires only one isometric view, where such locations are unnecessary. This method also simplifies the placing of signs, thereby reducing the chances for errors to a minimum, and resolves itself into a method of automatic substitutions and simple arithmetic operations in tables.

By applying ratios of cross-sectional moments of inertia to systems with different pipe branches, the same basic equations may be used for solution of forces acting at the centroid of a system with constant or different moments of inertia. By tabulating the coordinates of centroids of elbows and their products in the same way as the coordinates of straight pipe branches and their products, the procedure of tabulation and calculation are almost identical for systems containing only straight branches and systems containing both straight branches and elbows. Thus, by using this method an analyst can calculate the stresses in any one of the above systems almost as expediently as the simplest system, i.e., the system with constant cross-sectional moment of inertia and without any elbow.

In this method the moments and products of inertia of any system are calculated directly from the coordinates of centroids of individual pipe branches with respect to any set of arbitrarily chosen axes. This eliminates calculating the line inertia values with respect to the true centroidal axes of the system. The arbitrarily chosen axes can be placed in such a way that many of the coordinates to be listed are equal to zero, so the calculations for these coordinates become unnecessary.

According to the conventional method, one centroidal moment of inertia for each straight branch is tabulated twice; two centroidal moments of inertia are tabulated twice, and one centroidal product of inertia once, for each elbow. Thus, a system containing 5 straight branches and 4 elbows requires the tabulation of 30 centroidal values. This number increases with the number of pipe branches. In this method, however, a maximum of six summarized centroidal values needs to be tabulated for a system of any shape and any number of branches.

Tables 1, 2 and 3 appear on the following pages with data from Example 1 written in. Three numerical examples appearing in Parts 1, 2 and 3 of this series are given for piping systems with constant and different moments of inertia, and a system containing quarter bends. In the last example the table for line inertias is applied to a three-dimensional system and a single-plane system. Then, the author shows how to adapt this table to any single-plane system in general, i.e., a system not subjected to displacement perpendicular to its own plane. While the forces,

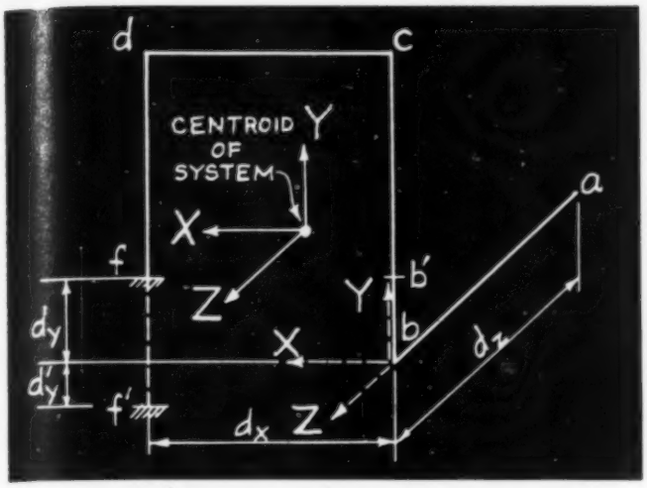


FIGURE 1—Piping system with a constant moment of inertia.

moments and stresses for simple single-plane systems can be calculated with minimum effort from tables given in many piping stress books, the aforementioned table for single-plane systems is most efficient for cases where the number of branches is great, or where the net expanding length for a system in any direction is different from the true length of the system in the same direction.

Piping System With Constant Moment of Inertia

A piping system with constant moment of inertia is shown in Figure 1.

For purpose of computation, we assume end f as fixed and end a in expansion. The forces X, Y and Z, which resist this expansion at a, are transferred to the centroid of the system which is behind the bcdf plane. These forces are shown in opposite directions to expansion but in the same directions as the centroidal axes. The dotted lines at b represent the original "arbitrarily" chosen axes, which will be used instead of the centroidal axes for computation of line inertias and will be explained later.

The fundamental equations for solution of X, Y and Z forces acting at the centroid of the system, caused by thermal expansion can be derived from the Elastic Energy Theory. These are

$$XI_x - YI_{xy} - ZI_{xz} = \frac{\triangle xEI}{1728} \quad (1)$$

$$-XI_{xy} + YI_y - ZI_{yz} = \frac{\triangle yEI}{1728} \quad (2)$$

$$-XI_{xz} - YI_{yz} + ZI_z = \frac{\triangle zEI}{1728} \quad (3)$$

$$\triangle x = \frac{d_x e}{100}, \triangle y = \frac{d_y e}{100}, \triangle z = \frac{d_z e}{100} \quad (4)$$

Where

I_x, I_y, I_z = moments of inertia of the piping system about its centroidal axes. ($ft.^2$)

I_{xy}, I_{xz}, I_{yz} = products of inertia of the system about the same axes. ($ft.^2$)

$\triangle x, \triangle y, \triangle z$ = total thermal expansion of the system in the X, Y, and Z directions respectively. (inches)

E = modulus of elasticity of the piping material at operating temperature. (pounds per square inch.)

I = moment of inertia of the cross-sectional metal area of the pipe. ($in.^4$)

d_x, d_y, d_z = net lengths of the piping system which expand in X, Y, and Z directions respectively.

e = thermal expansion in 100 feet of pipe due to a rise from installation temperature to operating temperature. (inches.)

Substituting Eq. (4) in Eqs. (1), (2), and (3), the right hand terms of the latter become $\frac{d_x eEI}{172{,}800}$, $\frac{d_y eEI}{172{,}800}$ and $\frac{d_z eEI}{172{,}800}$. Substituting an expansion factor $c^* = \frac{eE}{172{,}800}$ in these terms, and dividing Eqs. (1), (2) and (3) by line inertias I_x, I_{xy}, and I_{xz} respectively, we obtain

$$X - Y\frac{I_{xy}}{I_x} - Z\frac{I_{xz}}{I_x} = \frac{d_x cI}{I_x} \quad (5)$$

$$-X + Y\frac{I_y}{I_{xy}} - Z\frac{I_{yz}}{I_{xy}} = \frac{d_y cI}{I_{xy}} \quad (6)$$

$$-X - Y\frac{I_{yz}}{I_{xz}} + Z\frac{I_z}{I_{xz}} = \frac{d_z cI}{I_{xz}} \quad (7)$$

The coefficients in the above equations are obtained in Table 1 and are designated with the following lettered circles, which eliminate the necessity of handling large figures of line inertia values themselves.

$$L = \frac{I_{xy}}{I_x} \quad M = \frac{I_{xz}}{I_x} \quad N = \frac{d_x cI}{I_x}$$

$$P = \frac{I_y}{I_{xy}} \quad Q = \frac{I_{yz}}{I_{xy}} \quad R = \frac{d_y cI}{I_{xy}} \quad (8)$$

$$S = \frac{I_{yz}}{I_{xz}} \quad T = \frac{I_z}{I_{xz}} \quad U = \frac{d_z cI}{I_{xz}}$$

If the fixed point with respect to expansion in Figure 1 is changed from f to f' due, for instance, to the upward expansion of a vessel at the same temperature, connected to the system at f and anchored at f', then the net expanding length in Y direction is d'_y instead of d_y, and the direction of the force Y is reversed. The flexibility of the system, however, is not changed, so that the same length "df" is used in line inertia calculations. If the above vessel is at a different temperature, its thermal expansion e' and c' are different from those of the piping. In this case, denoting length with $l, l_{bb'}c - l_{ff'}c'$ should be substituted for $d_y c$ in Eq. (6). The total expansion in Y-direction is then, from Eq. (4),

$$\triangle y = \frac{1}{100}(l_{bb'}e - l_{ff'}c') \quad (9)$$

Eq. (4) or Eq. (9) are used for calculation of actual ex-

About the Author

K. HAO HSIAO received B.A. and M.A. degrees from Stanford University. Following graduation he was employed in the Mechanical Engineering department of Ohio State University. He later worked with Aluminum Limited in Montreal and as a stress engineer with Canadair Limited in the same city. He was also employed by Stadler, Hurter & Company, consulting engineers. He is now a structural designer with Ralph M. Parsons Company in Los Angeles.

[2] Numerical values of "c" are given in "Piping Stress Calculations Simplified," S. W. Spielvogel, p. 93.

pansions in a system for purpose of determining "cold spring," but are not required in the tables presented herewith.

According to the procedure of calculation in Table 1, the moments and products of inertia of a piping system are calculated directly by using the original arbitrarily chosen axes. This procedure is based on the following equations:

Plane	Equation
	i = All Branches i = Bran. ⊥ Plane
X - Y	$I'_x = \sum l_i y_i^2 + 0.3 \sum l_i y_i^2$
	i = All Branches i = Bran. ⊥ Plane
	$-\bar{y}^2 \left[\sum l_i + 0.3 \sum l_i \right]$
Y - Z	I''_x = same as above
X - Y	$I'_y = \sum l_i x_i^2 + 0.3 \sum l_i x_i^2 - \bar{x}^2 \left[\sum l_i + 0.3 \sum l_i \right]$
X - Z	I'_z = same as above
X - Z	$I''_z = \sum l_i z_i^2 + 0.3 \sum l_i z_i^2 - \bar{z}^2 \left[\sum l_i + 0.3 \sum l_i \right]$
Y - Z	I''_y = same as above
	$I_{ox} = \frac{1}{12} \sum (l_y^2 + l_z^2)$
	$I_{oy} = \frac{1}{12} \sum (l_x^2 + l_z^2)$
	$I_{oz} = \frac{1}{12} \sum (l_x^2 + l_y^2)$
	$I_x = I'_x + I''_x + I_{ox}$
	$I_y = I'_y + I''_y + I_{oy}$
	$I_z = I'_z + I''_z + I_{oz}$
	i = All Branches i = Bran. ⊥ Plane
X - Y	$I_{xy} = \sum l_i x_i y_i + 0.3 \sum l_i x_i y_i$
	i = All Branches i = Bran. ⊥ Plane
	$-\bar{x}\bar{y} \left[\sum l_i + 0.3 \sum l_i \right]$
X - Z	$I_{xz} = \sum l_i x_i z_i + 0.3 \sum l_i x_i z_i - \bar{x}\bar{z} \left[\sum l_i + 0.3 \sum l_i \right]$
Y - Z	$I_{yz} = \sum l_i y_i z_i + 0.3 \sum l_i y_i z_i - \bar{y}\bar{z} \left[\sum l_i + 0.3 \sum l_i \right]$

(10)

Where

x, y, z = coordinates of the centroid of each piping branch with respect to the original arbitrarily chosen X, Y and Z axes.

$\bar{x}, \bar{y}, \bar{z}$ = coordinates of the centroid of the piping system with respect to the original arbitrarily chosen X, Y and Z axes.

l = length of each piping branch.

l_x, l_y, l_z = lengths of piping branches parallel to X, Y and Z axes respectively.

I_{ox}, I_{oy}, I_{oz} = sums of centroidal moments of inertia of the above lengths about their own respective neutral axes.

The same "i" is used over the summation signs of all terms in each column in Eq. (10). For clarity of presentation, it is given only over the summation sign for I'_x and I_{xy} and is not repeated for terms below them.

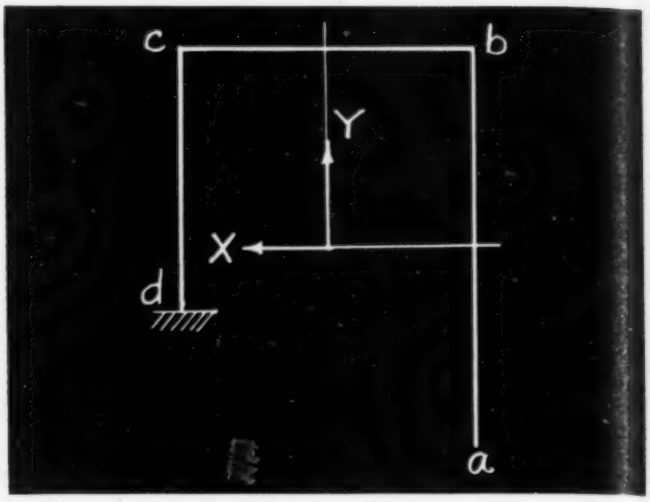


FIGURE 2—Single plane piping system: X and Y axes pass through the the individual centroids of least two branches.

The procedure indicated in Eq. (1) eliminates the necessity of tedious and error-prone process of locating in three perpendicular planes (in addition to an isometric view): (1) the true centroidal axes of the piping system, (2) the coordinates with respect to these axes of individual centroids of different piping branches (for calculation of line inertia values), and (3) the coordinates of ends and joints between the piping branches (for calculation of moments and torques). Therefore, in addition to the simplification in numerical calculations, the resulting procedure of calculations in accordance with Table 1 requires only a simple isometric view of the system, where such locations are unnecessary.

Table 1 contains a "Basic Table," in which are listed the numerical values of the centroid coordinates x, y and z and length l of each piping branch, their products and their respective "Basic Sums." [See Table 1, row (1).] Then the values for branches in torsion in each perpendicular plane is increased by 30 percent to take into account their torsional effect on flexibility [See rows (2), (3), (7), (8), (12), 13)], resulting in different final values for each plane. These final values are used to compute locations of centroidal axes, line inertia values and the ratios of these inertia values in Eqs. (8) [See row (20)]. These ratios are to be inserted in Table 2 for solution of X, Y, and Z forces indicated in Eqs. (5), (6), and (7).

The arithmetic operations are given in the left-hand margin of Table 2, and are self-explanatory. These forces are then inserted in Table 3 to calculate the moments and torques about each end or joint of the piping system. Thus, there are two moments for each end or joint in each plane as indicated in rows (1), (2), (3), (4), (5), and (6) of Table 3.

The signs of these moments are obtained from the directions of the X, Y and Z forces and the signs of their moment arms, i.e., $x - \bar{x}$, $y - \bar{y}$ and $z - \bar{z}$ by means of

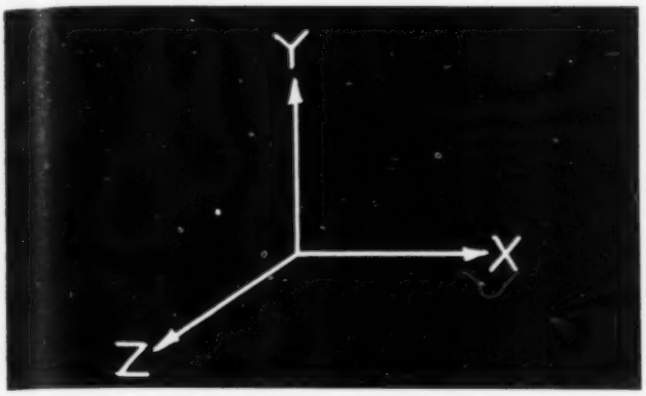


FIGURE 3—Three dimensional analysis: Apply right palm rule for signs.

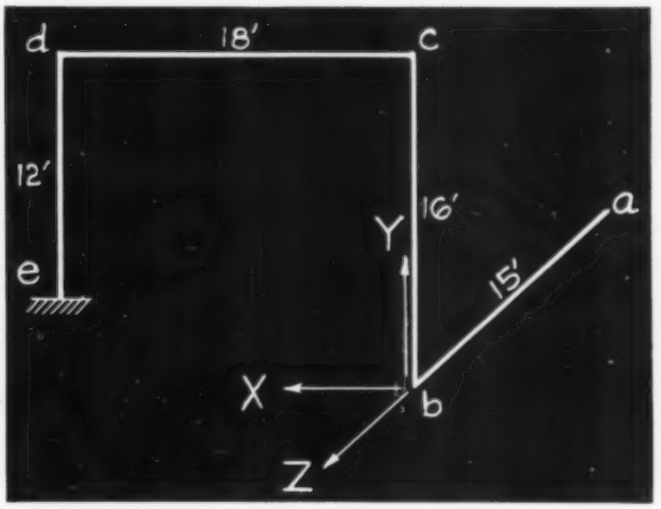


FIGURE 4—Piping system with constant cross-sectional moment of inertia, I = 160.8 in.⁴

the "Right Palm Rule," (stated later). The algebraic sum of these moments in each plane gives the resultant moment in that plane, i.e., M_{xy}, M_{xz} or M_{yz}. Two of the resultant moments are bending moments, from which the combined bending moment and bending stress can be obtained. The third moment is actually a torque, from which the torsional stress can be found.

While the number of rows in the "Basic Table" increases with number of pipe branches, the remaining portion of Table 1 contains exactly the same number of rows or figures regardless of the shape or number of branches in a system. Thus, doubling the number of branches only increases the number of rows in the "Basic Table" to twice its original number. In other words, if the number of branches is increased from five to ten, the only change in Table 1 is the tabulation of five additional rows in the "Basic Table." Therefore, the greater the number of branches in a system, the greater is the extent of simplification in computations. When the three dimensional system reduces to its simplest form, i.e., a system of three pipe branches, rows (2), (7) and (12) may be left blank.

Since the locations of original X, Y and Z axes may be chosen "arbitrarily," it is best to select axes such that these axes, if extended, will pass through a maximum number of centroids of branches. Such a selection of axes decreases greatly the number of coordinates to be listed in Table 1, thereby cutting down the time and labor required for calculations. The author prefers the following selection: in a three-dimensional piping system, two of the axes are placed in a plane containing the greatest number of piping branches, while the third axis is colinear with a branch perpendicular to this plane. Such a selection is shown in Figure 1 as dotted lines and also in Example 1. In a single-plane system, the axes X and Y, if extended, pass through the individual centroids of at least two branches of the piping as shown in Figure 2. Such a selection is made in Example 3 for both single-plane and three-dimensional systems for comparison with Example 1.

Pipe Stresses

The moments and torques from Table 3 can be used to compute bending and torsional stresses at any point in a piping system. They are usually calculated for points of maximum bending moment and at the nozzles of vessels and equipment. The longitudinal stress f_l is the sum of bending stress f_b due to thermal expansion and axial stress f_p due to pressure inside the system. Hence,

$$f_l = f_b + f_p = \frac{M}{S} + p\left(\frac{A_i}{A_m}\right) \qquad (11)$$

where M = bending moment (in.-lb.)
S = section modulus (in.³)
p = internal pressure (psi)
A_i = cross-sectional area inside pipe (in.²)
A_m = cross-sectional metal area of pipe (in.²)

The torsional shear stress f_t is

$$f_t = \frac{T}{2S} \qquad (12)$$

where T = torque (in.-lb.)

The circumferential stress f_c is

$$f_c = 2f_p \text{ (approximate with sufficient accuracy)} \qquad (13)$$

The combined stress is then

$$f = \tfrac{1}{2}\left[f_l + f_c + \sqrt{4f_t^2 + (f_l - f_c)^2}\right. \qquad (14)$$

Right Palm Rule

This simple rule is used to determine quickly signs of moments and torques in Table 3. Assume the original arbitrarily chosen axes as shown below, their positive directions being opposite to the directions of thermal expansion Δx, Δy and Δz respectively. [See Eq. (4)]

Thus, the X-Y plane is parallel to paper, and the Z-axis is perpendicular to paper. The analyst should view X-Y plane by looking down at the paper, X-Z plane from top of paper and Y-Z plane from right side of paper. Then, open the right palm, and point the thumb in the direction of a force and the remaining fingers in the direction of centroidal distance of a point in the piping system (end or joint), i.e., the direction of coordinate $x - \bar{x}$, $y - \bar{y}$ or $z - \bar{z}$ in Table 3. If the palm is toward the analyst, the moment or torque is negative. If the back of the hand is toward the analyst, it is a positive value. For instance, in Example 1 for point a in X-Y plane, since the sign of $y - \bar{y}$ is negative (—8.19 ft.), point right thumb in the direction of X force and the remaining fingers in the direction of negative Y-axis. In this case, the palm of the right hand is toward the

BRANCH	X	Y	Z	l	lx	lx²	ly	ly²	lz	lz²	lxy	lxz	lyz
ab	0	0	-7.5	15	0	0	0	0	-112.5	844	0	0	0
bc	0	+8	0	16	0	0	+128	1024	0	0	0	0	0
cd	+9	+16	0	18	+162	1458	+288	4608	0	0	+2592	0	0
de	+18	+10	0	12	+216	3888	+120	1200	0	0	+2160	0	0
(1) BASIC SUM				61	+378	5346	+536	6832	-112.5	844	+4752	0	0
X-Y	(2) SUM OF BRANCHES PARA. TO Z-AXIS: ab												
	(3) = (2) × 0.3			4.5	0	0	0	0			0		
	(4) Σ = (1) + (3)			65.5	+378	5346	+536	6832			+4752		
	(5) SEE NOTES				x̄ +5.77	Ⓐ +2180	ȳ +8.19	Ⓑ +4390			Ⓒ +3095		
	(6) = (4) − (5)					I'_y 3166		I'_x 2442			I_{xy} 1657		
X-Z	(7) SUM OF BRANCHES PARA. TO Y-AXIS: bc + de			28	+216	3888			0	0		0	
	(8) = (7) × 0.3			8.4	+64.8	1166.4			0	0		0	
	(9) Σ = (1) + (8)			69.4	+442.8	6512.4			-112.5	844		0	
	(10) SEE NOTES				z̄ +6.38	Ⓓ +2825			z̄ -1.622	Ⓔ +182.6		Ⓕ -718	
	(11) = (9) − (10)					I''_z 3687.4				I''_y 661.4		I_{xz} +718	
Y-Z	(12) SUM OF BRANCHES PARA. TO X-AXIS cd												
	(13) = (12) × 0.3			5.4			+86.4	1382.4	0	0			0
	(14) Σ = (1) + (13)			66.4			+622.4	8214.4	-112.5	844			0
	(15) SEE NOTES						ȳ +9.375	Ⓖ +5840	z̄ -1.695	Ⓗ +190.7			Ⓚ -1055
	(16) = (14) − (15)							I''_x 2374.4		I''_y 653.3			I_{yz} +1055
(17) SEE NOTES						I_{ox} 767.3		I_{ox} 971		I_{ox} 766.5			
(18) $I'_x+I''_x+I_{ox}=I_x$ $I'_y+I''_y+I_{oy}=I_y$ $I'_z+I''_z+I_{oz}=I_z$						I_y 4586.6		I_z 7032.8		I_x 3869.7			
(19) FROM (6), (11), (18)						I_{xy} 1657		I_{xz} 718			I_x 3869.7	I_y 3869.7	I_{xy} 1657	I_{yz} 718
(20) Ⓟ=(18)÷(19) Ⓣ=(18)÷(19) Ⓛ=(6)÷(19)						Ⓟ 2.77		Ⓣ 9.8			Ⓛ .428	Ⓜ .186	Ⓠ .637	Ⓢ 1.47
Ⓜ=(11)÷(19) Ⓠ=(16)÷(19) Ⓢ=(16)÷(19)														

NOTES

$\bar{x} = \frac{\Sigma lx}{\Sigma l}$ Ⓐ,Ⓓ − $\bar{x}\Sigma lx$ Ⓔ − $\bar{z}\Sigma lx$ $\frac{\Sigma l_y^3}{12} = \frac{18^3}{12} = 486$ $I_{ox} = 485 + 281.3 = 766.3$ Ⓝ $= \frac{d_x c I}{I_x} = \frac{18(874)\,160.8}{3869.7} = 654$

$\bar{y} = \frac{\Sigma ly}{\Sigma l}$ Ⓑ,Ⓖ − $\bar{y}\Sigma ly$ Ⓒ − $\bar{y}\Sigma lx$ $\frac{\Sigma l_x^3}{12} = \frac{16^3 + 12^3}{12} = 485$ $I_{oy} = 486 + 281.3 = 767.3$ Ⓡ $= \frac{d_y c I}{I_{xy}} = \frac{4(874)\,160.8}{1657} = 339$

$\bar{z} = \frac{\Sigma lz}{\Sigma l}$ Ⓔ,Ⓗ − $\bar{z}\Sigma lz$ Ⓚ − $\bar{z}\Sigma ly$ $\frac{\Sigma l_z^3}{12} = \frac{15^3}{12} = 281.3$ $I_{oz} = 486 + 485 = 971$ Ⓤ $= \frac{d_z c I}{I_{xz}} = \frac{15(874)\,160.8}{718} = 2940$

TABLE 1—Moments and products of inertia for square-corner systems: Data for "Example 1" are inserted.

analyst so the moment $X(y - \bar{y})$ is a negative value (—8190). Using the same rule, the moment $Y(x - \bar{x})$ is a positive value (+3440). The total moment M_{xy} at point a is the algebraic sum of the two values or —4750 ft.-lb. When the force is a negative value, indicating its direction opposite to that assumed originally, the analyst should point the thumb in the same negative direction. This is illustrated by the X force (—658 lb.) in Table 3 of Example 3.

Although the positive direction of any one of the axes shown above may be reversed due to reversal of direction of expansion along that axis, it is convenient for the analyst to use the same notations for the axes, i.e., X and Y for axes in a plane parallel to paper.

EXAMPLE 1

A piping system with constant cross-sectional moment of inertia I = 160.8 in.⁴ (10 inch diameter, schedule 40) is shown in Figure 4. The analysis of this system is carried out in Tables 1, 2 and 3 in accordance with the procedure given above.

Carbon Steel
10 in. diam., sch. 40
I = 160.8 in.⁴
S = 29.9 in.³
A_i = 78.9 in.²
A_m = 11.91 in.²

T = 750° F.
c = 874
p = 420 psig

(1)		Ⓛ -.428	Ⓜ -.186	Ⓝ 654
(2)		Ⓟ 2.770	Ⓠ -.637	Ⓡ 339
(3)		Ⓢ -1.470	Ⓣ 9.800	Ⓤ 2,940
(4)	(1)+(2)	2.342	ⓐ -.823	993
(5)	(1)+(3)	-1.898	ⓑ 9.614	3,594
(6)	(5)×$\frac{ⓐ}{ⓑ}$	ⓒ -.162	ⓐ .823	ⓓ 307.6
(7)	(4)+(6)	ⓔ 2.180		ⓕ 1300.6

$Y = \frac{ⓕ}{ⓔ} = \frac{1300.6}{2.18} = 597$ lb

$Z = \frac{ⓓ + ⓒ Y}{ⓐ} = \frac{307.6 + .162(597)}{.823} = 491$ lb.

$X = Ⓝ + Ⓛ Y + Ⓜ Z$
$= 654 + .428(597) + .186(491)$
$= 1001$ lb.

TABLE 2—Forces.

Although the maximum moment in Table 3 occurs at "c," the second largest moment with a much greater torque occurs at "e," resulting in the maximum stress for the entire system. This is shown in the following calculations:

	POINT / COORD.	a	b	c	d	e			
	X	0	0	0	+18	+18			
	Y	0	0	+16	+16	+4			
	Z	-15	0	0	0	0			
X-Y	PLANE	$\bar{X}$ = +5.77			Y = 597				
	X-$\bar{X}$	-5.77	-5.77	-5.77	+12.23	+12.23			
(1)	MULT. Y	+3440	+3440	+3440	-7300	-7300			
		$\bar{Y}$ = +8.19			X = 1001				
	Y-$\bar{Y}$	-8.19	-8.19	+7.81	+7.81	-4.19			
(2)	MULT. X	-8190	-8190	+7810	+7810	-4190			
(1)+(2)	M_{XY}	-4750	-4750	+11,250	+510	-11,490			
X-Z	PLANE	$\bar{X}$ = +6.38			Z = 691				
	X-$\bar{X}$	-6.38	-6.38	-6.38	+11.62	+11.62			
(3)	MULT. Z	-3130	-3130	-3130	+5710	+5710			
		$\bar{Z}$ = -1.62			X = 1001				
	Z-$\bar{Z}$	-13.38	+1.62	+1.62	+1.62	+1.62			
(4)	MULT. X	+13,380	-1,620	-1,620	-1,620	-1,620			
(3)+(4)	M_{XZ}	+10,250	-4750	-4750	+4090	+4090			
Y-Z	PLANE	$\bar{Y}$ = +9.38			Z = 691				
	Y-$\bar{Y}$	-9.38	-9.38	+6.62	+6.62	-5.38			
(5)	MULT. Z	-4600	-4600	+3250	+3250	-2040			
		$\bar{Z}$ = -1.70			Y = 597				
	Z-$\bar{Z}$	-13.3	+1.70	+1.70	+1.70	+1.70			
(6)	MULT. Y	+7950	-1017	-1017	-1017	-1017			
(5)+(6)	M_{YZ}	+9350	-5617	+2233	+2233	-3057			

MAX. $M = M_c = \sqrt{M_{xy}^2 + M_{xz}^2} = \sqrt{11,250^2 + 4,750^2} = 12,200$ Ft.-lb.

$T_c = 2,233$ Ft.-lb. $M_e = \sqrt{11,490^2 + 3,657^2} = 12,030$ Ft.-lb. $T_e = 4,090$ Ft.-lb

TABLE 3—Moments and torques: Data for "Example 1" are inserted.

At "c"

$$f_1 = \frac{12,200\ (12)}{29.90} + 420\left(\frac{78.9}{11.91}\right) = 4,900 + 2,782 = 7,682 \text{ psi}$$

$$f_2 = 2\ (2,782) = 5,564 \text{ psi}$$

$$f_3 = \frac{2,233\ (12)}{2\ (29.9)} = 448 \text{ psi}$$

$$f = \tfrac{1}{2}[7,682 + 5,564 + \sqrt{4\ (448)^2 + (7,682 - 5,564)^2}] = 7,772 \text{ psi}$$

At "e"

$$f_1 = \frac{12,030\ (12)}{29.90} + 2,782 = 7,612 \text{ psi}$$

$$f_2 = 2\ (2,782) = 5,564 \text{ psi}$$

$$f_3 = \frac{4,090\ (12)}{2\ (29.9)} = 820 \text{ psi}$$

$$f = \tfrac{1}{2}[7,612 + 5,564 + \sqrt{4\ (820)^2 + (7,612 - 5,564)^2}] = 7,900 \text{ psi}$$

Simplification of Table 3

If only the maximum combined moment and its corresponding torque are required, then it is not necessary to obtain the true values of moments and torques at all points. In this case, their relative values may be used for comparison purposes, and the maximum relative values are chosen to calculate the true maximum combined moment. The calculations are accomplished in Table 3A. This table is especially convenient when the piping system consists of a large number of branches.

	POINT / COORD.								
	X								
	Y								
	Z								
X-Y	PLANE	$\bar{x}$ =		Y' = Y/X =				$\bar{y}$ =	
	X-$\bar{x}$								
(1)	MULT. Y'								
(2)	Y-$\bar{y}$								
(1)+(2)	M_{XY}								
X-Z	PLANE	$\bar{x}$ =		Z' = Z/X =				$\bar{z}$ =	
	X-$\bar{x}$								
(3)	MULT. Z'								
(4)	Z-$\bar{z}$								
(3)+(4)	M_{XZ}								
Y-Z	PLANE	$\bar{y}$ =		Z' =					
	Y-$\bar{y}$								
(5)	MULT. Z'								
		$\bar{z}$ =		Y' =					
	Z-$\bar{z}$								
(6)	MULT. Y'								
(5)+(6)	M_{YZ}								

MAX. $M = M = X\sqrt{M^2 + M^2} =$

$T =$

TABLE 3A—Moments and torques: For cases where only the maximum combined moment and its corresponding torque are required, this table will simpify the operation.

NOMENCLATURE

l, x, y, z = length and coordinates of the centroid of each piping branch or elbow (ft).

$\bar{x}, \bar{y}, \bar{z}$ = coordinates of the centroid of piping system (ft.)

I_x, I_y, I_z = moments of inertia of the system about its centroidal axes (ft.^{3})

I_{xy}, I_{xz}, I_{yz} = products of intertia of the system about its centroidal axes (ft.^{3})

l_x, l_y, l_z = lengths of piping branches parallel to X, Y and Z axes (ft.)

I_{ox}, I_{oy}, I_{oz} = sums of centroidal moments of inertia of the above lengths and elbows about their own respective neutral axes (ft.^{3}) [see Eq. (10) or Eq. (22)]

$I_{oxy}, I_{oxz}, I_{oyz}$ = sums of centroidal products of inertia of elbows. (ft.^{3}) [see Eq. (21)]

d_x, d_y, d_z = net lengths of the system expanding in X, Y and Z directions respectively (ft.)

I = cross-sectional moment of inertia of the pipe (in.^{4})

S = section modulus of pipe (in.^{3})

D = outside diameter of pipe (in.)

t = thickness of pipe wall (in.)

A_i = inside area of pipe (in.^{2})

Am = cross-sectional metal area of pipe (in.^{2})

T = temperature (° F)

p = pressure inside pipe (psig)

R = radius of curvature of elbow (ft.)

c = expansion factor (see "Piping Stress Calculations Simplified," by S. W. Spielvogel, P. 93)

ω = flexibility modification factor [see Eq. (18) and Figure 7]

λ = characteristics factor [see Eq. (19)]

X, Y, Z = forces due to expansion (lb.)

M_{xy}, M_{xz}, M_{yz} = bending moments due to X, Y and Z forces (one of these moments is actually a torque) (ft.-lb.)

(Parts 2 and 3 will appear in coming issues.)

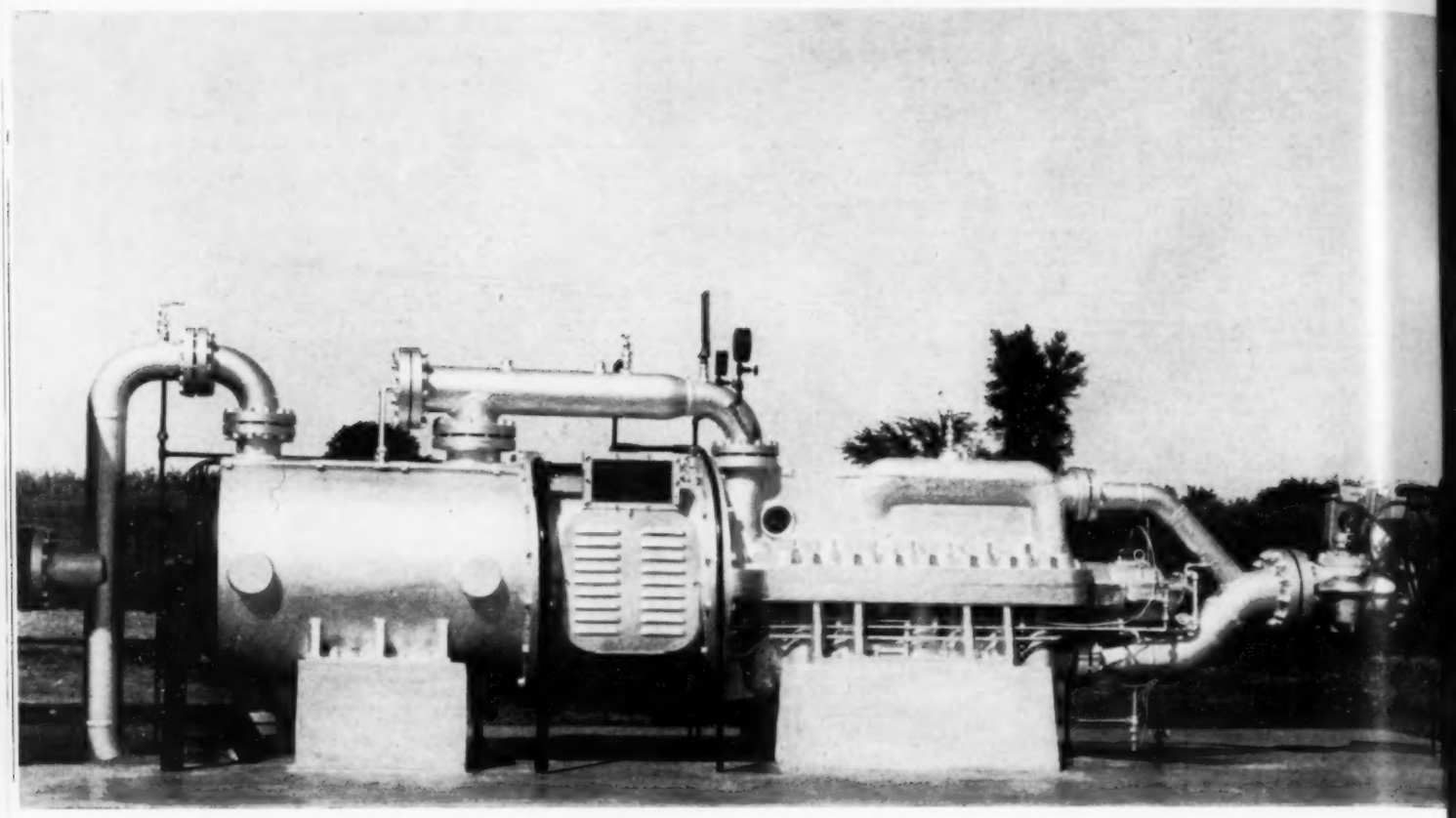


FIGURE 1—In operation since 1933, this Rannett-type pipe line pump with 700-hp liquid-cooled motor and totally enclosed squirrel cage induction motor drive was early adaptation of total motor enclosure on pipe line drive in outdoor unprotected installation.

Why the trend is toward . . . .

Larger Electrical Drives

. . . and how the great reliability developed in motors makes this possible.

By D. N. HIGH and F. C. OSTERLAND
Allis-Chalmers Manufacturing Company

THESE FACTORS have been instrumental in the electrification of pumping station drives:

1. The introduction of high-speed centrifugal pumps which can be directly connected to electric motors.

2. The general improvement in electrical transmission systems, so that reliability of service is no longer questioned.

3. Automatic or remote control features of full electrification.

4. Reduced costs for operating personnel and motor maintenance, when compared to those for other drives, is an economic factor.

Motor Enclosures. The motors first adapted were of the open-type, as special protective enclosures and the meeting of insurance standards were unimportant in pipe line station economics.

The Rannett-type motor-pump

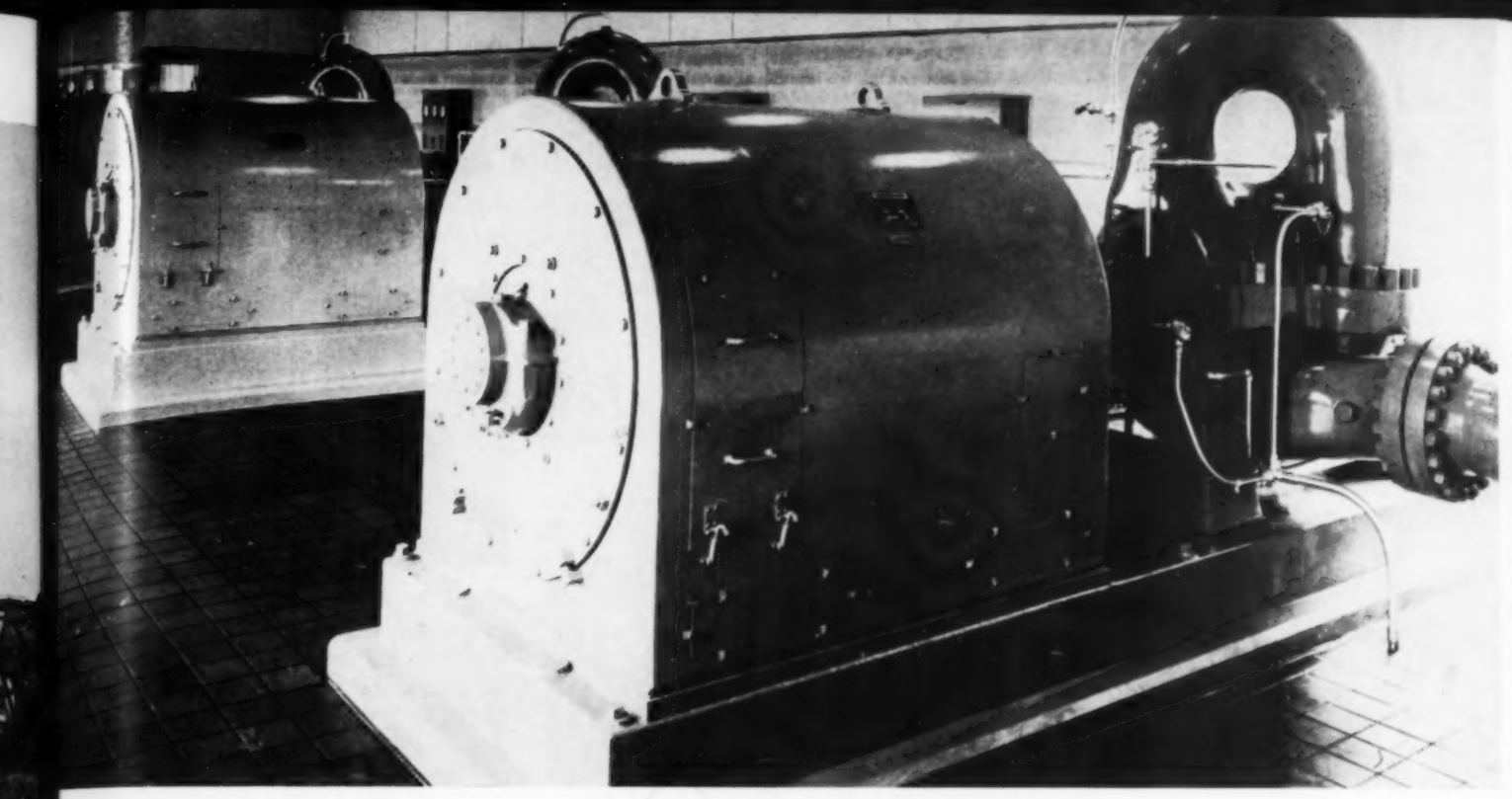


FIGURE 2—1250-hp, 1780-rpm motors carry Underwriters' label for operation in Class I, Group D hazardous areas.

combination (Figure 1), in operation since 1933, has a totally-enclosed squirrel cage induction motor drive. The pumped product is the cooling medium in this unusual arrangement, being pumped through an air-to-liquid heat exchanger surrounding the motor's stator yoke to maintain the proper operating temperature within the machine. This represents one of the earlier designs with a weather-proof housing that demanded no other protection. Despite the elimination of external housing, this type of construction proved very costly and was not adopted widely.

Totally-enclosed designs using air-to-air heat exchange have proved more successful and have been widely adopted throughout the oil industry. Motors of this type offer not only complete protection, but can be built to withstand external explosions.

Explosion-proof ratings range from the very small up to the 3000-horsepower machines, all with Underwriters Laboratories' approval for operation in Class I, Group D hazardous locations. The 1250-hp motors (Figure 2) are the tube-type TEFC design in which cooling air for active motor parts circulates between a nest of tubes completely surrounding the yoke. A separate fan forces outside air through the tubes which act as heat exchangers to keep the motor within allowable temperature limits.

Water-cooled motors can be constructed so motor parts operate in an atmosphere of inert gas which would not sustain an explosion. Disadvantages of inert gas-filled motors are the water requirements of the heat exchanger and the special facilities necessary to maintain the inert gas under pressure within the motor enclosure.

Totally-enclosed motors are relatively expensive in the larger ratings. Equivalent costs for a tube-type explosion-proof enclosure are approximately 105 percent (at 2000 hp-1800 rpm) and 95 percent (at 3500 hp-1800 rpm) more than open machine costs. For the same ratings, the inert gas-filled enclosure ranges approximately 25 to 50 percent above open machine costs.

Various schemes have been used in an effort to reduce motor costs without sacrificing safety. There are stations where open motors and pumps are separated by a firewall (Figure 4, but buildings of this type are in themselves quite costly.

Forced-ventilated motors have proved successful in some stations driving both pumps and compressors. These (Figure 3) are ventilated through openings in each end of the base with air ducted from a safe external source. Discharge air passes out at the middle of the base and is vented outside the building. A separate blower at the duct intake forces air to the motors under positive pressure so that any leakage will be outward to exclude contaminants. All electrical connections to these machines are inside the enclosure but accessible through a cover plate. For further safety, a control interlock insures that the blower system is in operation, purging the ducts and motor housing before motor operation can begin.

In weighing the economic balance between the TEFC and the forced-ventilated motor, the cost of the ventilating system must be considered. Motor costs alone for forced-ventilated enclosures are approximately 5 to 8 percent more than for equivalent open machines.

The outdoor weather-protected enclosure type (Figure 5) has been utilized for some pipe line drives. Air enters at the sides of the motor at low velocity and passes upward to a large chamber from which fans on each end of the motor rotor draw ventilating air to cool motor parts. Strong winds can blow completely through the external passages. Heavy moisture is excluded by this arrangement and filters can be provided to eliminate dust and dirt.

Types of Motors. By far the predominant type for pipe line drives is the squirrel cage induction motor. It offers simplicity in design and high

efficiency in operation. In addition, it is most easily adapted to TEFC construction. Controls, too, are relatively simple.

For certain pipe line operations, however, large synchronous motors are better suited. The power factor correction possible with base load synchronous machines is a factor that can, in some instances, be decisive. Single compressor stations, with motors rated 15,000 hp or better, can utilize synchronous drives to advantage. Where forced-ventilation is applied to such motors, the enclosing covers will embrace the motor, field collector rings, and the exciter.

Motor Application. Pipe line drives are generally tailored to the application, to suit hydraulic considerations and pump or compressor characteristics. As previously mentioned, centrifugal pumps and compressors re-

FIGURE 3—Base ventilated motors, rated 900 and 1750-hp, are installed in gas compressor station, but operate in atmosphere of uncontaminated air.

About the Authors

FRANK C. OSTERLAND has been associated with the motor and generator section of Allis-Chalmers Manufacturing Company since 1948. He is a graduate of North Central College, Naperville, Ill. and was a junior high school instructor in Racine, Wis., before joining Allis-Chalmers. Osterland is a lieutenant commander in the U. S. Naval Reserve and saw action in several Pacific campaigns during World War II. He is the author of a number of business paper articles.

DAVID N. HIGH has been associated with Allis-Chalmers since his graduation in 1947 as an electrical engineer from the University of Wisconsin. As a member of the company's graduate training course, High served in a number of departments and in 1948 he was assigned to the motor division of the motor and generator section, where he is presently an application engineer. High is a member of the American Institute of Electrical Engineers and is secretary-treasurer of the Milwaukee chapter of Kappa Eta Kappa, electrical engineering fraternity.

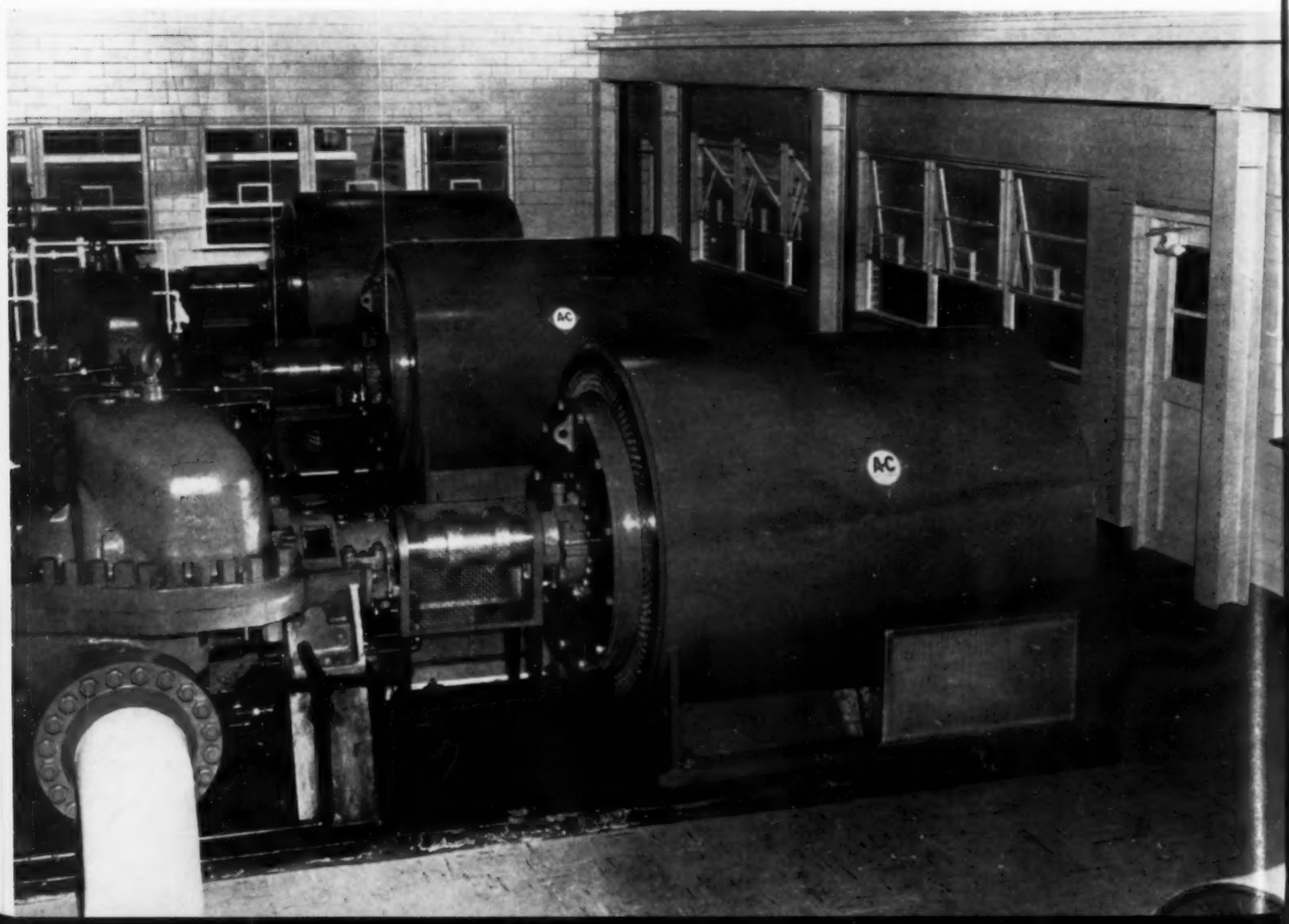


FIGURE 4 (Top)—1500-hp, 1780-rpm top air discharge motors. Firewall separates them from hazardous atmosphere of pump room on a crude pipe line.

quire high speed drives, and squirrel cage induction motors are applied.

Very large compressor units may dictate the use of large synchronous motor drives, with speed increasers. Wound rotor induction or direct current drives are not normally applied on pipe line service, except where adjustable speed is required.

Motor Protection. Pump and compressor drives are the heart-beat of the entire pipe line complex. Critical electrical motors can be protected against overloads and short circuits by simple relays on motor controllers. It is especially advisable, in automatic or remotely-controlled stations, to provide additional protection at the motor against damage due to internal faults and excessive temperatures. Some protective devices stop the motor automatically when a dangerous condition exists. Others give advance warning of dangerous conditions by sounding an alarm or lighting a warning lamp.

Detection of excessive temperatures in the stator and bearing structure is easily accomplished by means of bimetallic disc-type thermostats, thermocouples, or imbedded resistance-type temperature detectors. In remotely-controlled stations, such devices can be set to trip over a wide margin, so service will be more continuous.

For example, bearing temperature relays normally set to shut down the motor at 85° C. can be set as high as 100° C. This is especially advantageous in areas of occasional high ambient temperature.

Another protective measure which should not be overlooked, especially where motors are subject to periodic downtime, is the space heater. This device can be arranged to operate when the motor is shut down, to keep the temperature inside the machine enough above the dew point to prevent moisture condensation on insulation. —**The End**

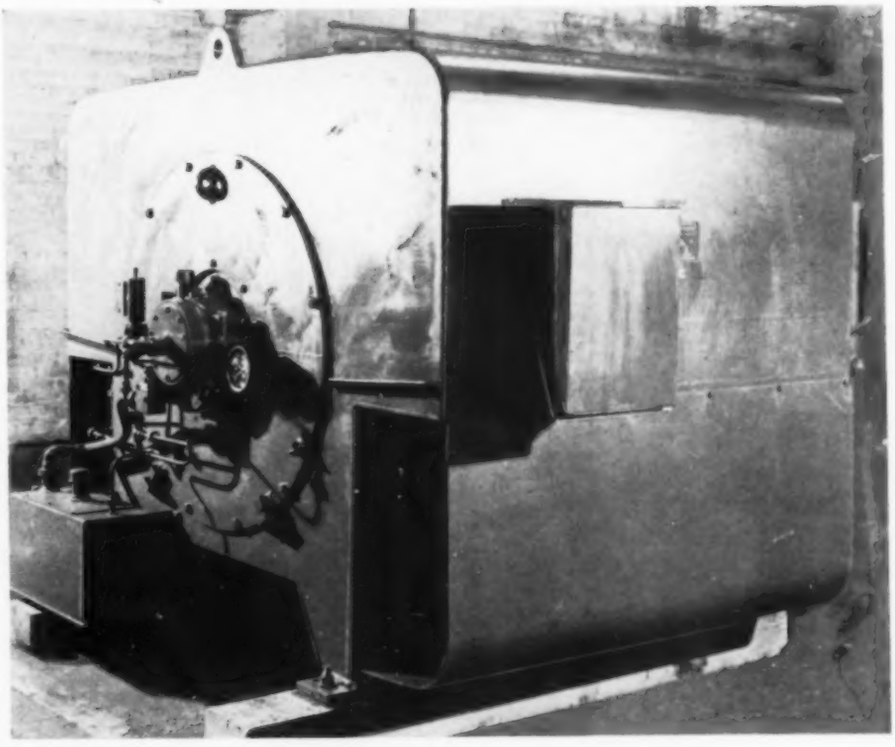
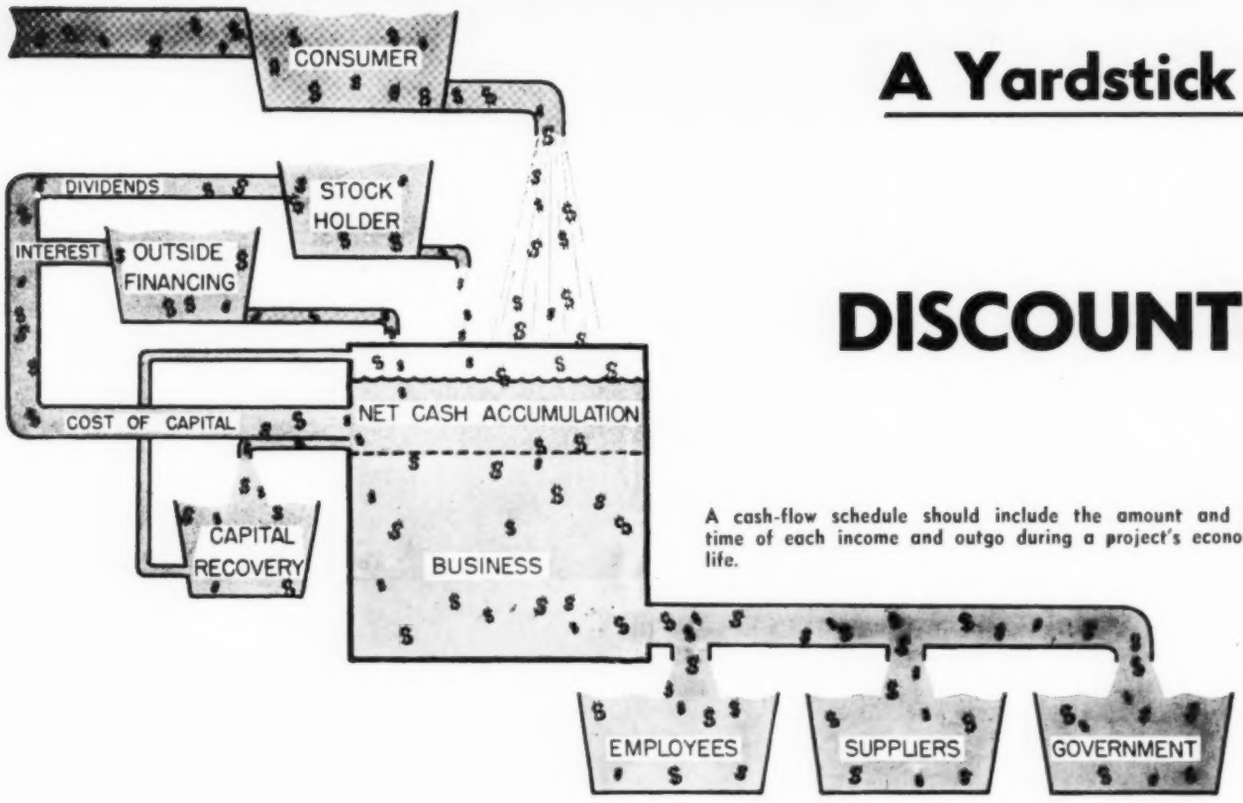


FIGURE 5—Outdoor weather-protected motors, rated 1000-hp, 3580-rpm, drives pump on crude oil pipe line.

A Yardstick for DISCOUNTED



A cash-flow schedule should include the amount and the time of each income and outgo during a project's economic life.

By G. V. ROHLEDER, Chief Engineer, Okan Pipeline Company, Tulsa

MANAGEMENT TODAY is caught in the middle on capital outlay decisions. Faced with the task of harmonizing the divergent objectives of stockholders, consumers and employes, management executives are recognizing the need for a realistic program for *creating, measuring* and *selecting* opportunitise.

But what are some of the elements of a capital outlay program? How should the economic worth of investment opportunities be measured?

Capital outlay can be defined as an expenditure of monies today for which the turnover into cash requires a period of years, and any benefits or profits are obtained from future operations. A capital outlay is necessary for the construction of new plants, additions, replacements, and modifications of existing plants. These long-term commitments as a rule establish a framework of policies upon which a company's success depends.

A capital outlay requires a forecast of the future. A great deal of risk is involved. Evaluation of these risks requires company-wide thinking, creative imagination, and judgment in predicting trends. Certain events can be predicted fairly accurately. Others can be forecast with less accuracy. Action is sometimes required when all the facts are not known.

Investment opportunities usually are analyzed by segments of the organization, but the final decision rests with top management. This situation points up the need for sound programs of evaluation.

Management is faced with a threefold task:

- Satisfying the three groups—stockholders, employes and consumers.
- Guaranteeing long-range survival of the company.
- Using its human and material resources at top efficiency.

Because of these conditions, capital outlays decisions are usually based either on profit or prestige. Even in those companies where the profit motive dominates, there are restrictions on the level of profits. These restrictions result primarily from competition—external and internal. There is external competition, when another company's trying to get the consumers dollars, and the government requires more taxes; internal competition comes from employes trying to increase their slice of the pie. As a consequence, the attitude changes from one of maximum profits to one of optimum profits and group satisfactions.

The prestige motive operates because a company wants to be known as one that does this-and-that for its employes, customers, etc. Good examples of investment from prestige motive are coffee lounges, modern offices, and recreational facilities.

In most companies, both motives are used to justify capital outlays. Whether the underlying motive is profit or prestige, management should make decisions on the basis of how much profit is expected, or foregone.

Elements of a capital outlay program. The success of a capital outlay program comes from management's conception and communication of five basic elements:

1. Management should set specific short and long term objectives (Master Plan). Objectives should be based on attainment intervals of 5, 10, 15 and 20 years or longer, and reviewed at specific intervals. These objectives should be set for organization, personnel, planning, profits, administration, costs, and betterment.

2. Management should develop a creative search for investment opportunities. Primary sources of ideas are the consumer, employes, competitors,

Evaluating Investments:

CASH FLOW METHOD

The discounted cash flow method emphasizes all aspects of an investment, whereas the more familiar payout method must be accompanied with supplementary data before a decision can be made. The accounting rate of return, a third method, poses problems of interpretation.

stockholders, suppliers, and financial institutions.

3. Management should measure the economic worth of all investment opportunities by means of a standard yardstick for acceptance or rejection.

4. Management should select the best opportunities on the basis of their effect on profits, how they fit into the master plan, and how they affect the profit-volume relationship.

5. Management should establish a control for the follow-up on decisions, so that changes can be made when the dynamics of the environment warrants. This follow-up must be continued from creation to disposal.

Criteria for a good yardstick. The major need is to measure—to accept or reject the economic worth of investment opportunities. What is the basis of a good reliable yardstick?

1. A good yardstick is objective; that is, it measures both earning power and group satisfactions.

2. It pinpoints the relative position of various projects.

3. It considers all aspects of cash flow.

4. It summarizes in a single figure all the relevant data.

5. It is sensitive enough to allow for uncertainties.

6. It indicates whether the project earnings are below the minimum accepted level.

Use of estimates and assumptions. The analysis of an investment opportunity is a prophecy of the future. It can be evaluated exactly only if the analyst has a complete knowledge of future events. Of course, obtaining this knowledge beforehand is impossible. So we have to use reasonable and clearly stated estimates and assumptions. The accuracy of any of our evaluations depends more on estimating and predicting basic costs than on the mechanics of applying a standard yardstick.

Historical costs are valuable as a guide for estimating future trends. However, we should bear in mind that these past occurrences do not necessarily repeat in the future.

Another important consideration is the introduction of *safety factors* into components of the total estimate. Any safety factor is a deliberate error. Errors tend to multiply in any evaluation formula, thereby creating a greatly exaggerated error in the final answer. The person making the final decision does not have time or should not be expected to become aware of

About the Author

GILBERT V. ROHLEDER, a director and chief engineer of Okan Pipeline Company, attended St. Joseph's College and Military Academy in Kansas. During World War II he served with the Second Infantry Division, and in 1945 entered Massachuetts Institute of Technology, receiving his S.B. degree in mechanical and industrial engineering in 1948. He was with Service Pipeline Company from 1948 to March, 1955, when he joined Okan. He is now supervisor of all engineering functions in the design and construction of the company's pipe line systems.

Three methods of calculating economic worth are considered: (1) pay out, (2) accounting rate of return, and (3) discounted cash flow.

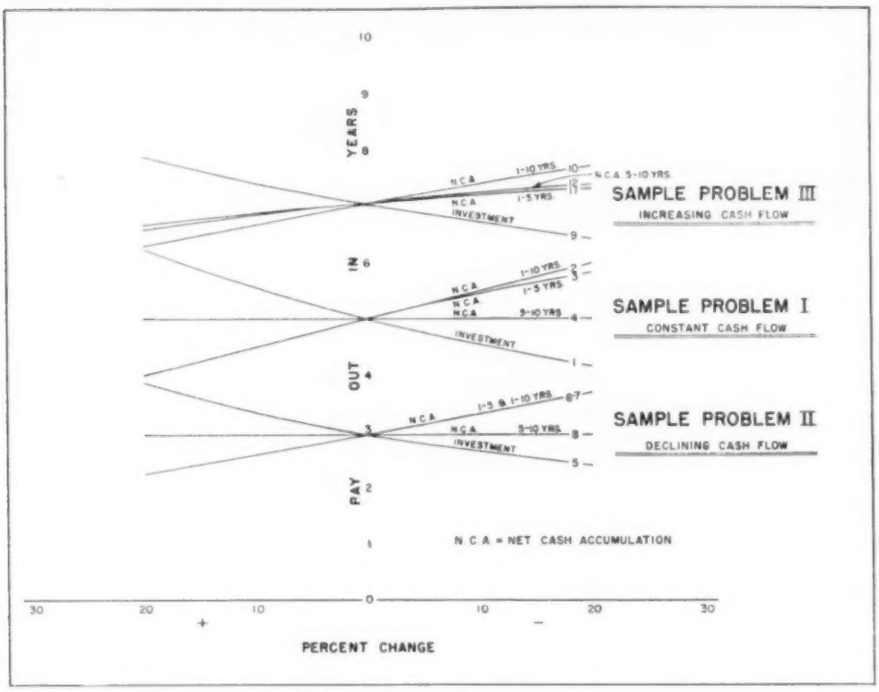


FIGURE 2

all safety factors introduced. Therefore, if any safety factor is to be used, it should be entirely managements' prerogative and applied when considering the final decision. It is entirely possible to "safety factor" a company out of business.

Preparing project analysis. A project analysis should include: (1) An estimate of the economic life; (2) An estimate of the cash flow pattern; and (3) An economic worth calculation.

Economic Life—A project's economic life is that period of time during which its profitableness is greater than any other known alternative. Factors that determine or fix economic life are:

1. Physical deterioration from the elements.

2. Depletion or exhaustion of an asset by piecemeal removal.

3. Wear and tear from use which cannot be restored by normal maintenance.

4. Inadequate capacity because of volume growth or changing demands.

5. Accidents caused by fires, floods, and explosions.

6. Obsolescence caused by technological improvements and innovations.

Improvements and innovations have occured so fast in recent years, that obsolescence has become the most important factor. Estimates of economic life can be made from actual mortality experience, projecting growth in volume and demand, projecting technological improvements, and projecting basic costs. The study of engineering valuation practices can provide the know-how for estimating all of the factors above.

Cash-Flow Pattern—A cash-flow schedule should include the amount and the time of each income and outgo during the economic life of any project. Figure 1 shows the cash-flow elements to be considered. Since at present a cycle of cash flow exists, only those changes in income and outgo resulting from a project need to be estimated. Statistical methods and probabilities play an important role in estimating, and may have to be used. Also, in our estimates, a plus sign indicates income and a minus sign, outgo.

Calculating Economic Worth—Three methods of calculating economic worth will be considered: (1) payout; (2) accounting rate of return; and (3) discounted cash flow. Let's use a simple illustration. Assume that a company has the opportunity to invest $20,000 in either Project 1, the purchase of a producing oil lease, or Project 2, the purchase of a new automatic machine, or Project 3, the purchase of a labor-saving jig. All three projects have the same life, and after considering yearly expenses, income taxes, etc., Table 1 shows the net amount of cash accumulated over a period of years.

The payout for each project is the number of years required to make the

TABLE 1

Time in Years	NET CASH FLOW		
	Project I	Project II	Project III
0	−20,000	−20,000	−20,000
0–1	+ 4,000	+ 7,600	+ 400
1–2	+ 4,000	+ 6,800	+ 1,200
2–3	+ 4,000	+ 6,000	+ 2,000
3–4	+ 4,000	+ 5,200	+ 2,800
4–5	+ 4,000	+ 4,400	+ 3,600
5–6	+ 4,000	+ 3,600	+ 4,400
6–7	+ 4,000	+ 2,800	+ 5,200
7–8	+ 4,000	+ 2,000	+ 6,000
8–9	+ 4,000	+ 1,200	+ 6,800
9–10	+ 4,000	+ 400	+ 7,600
Net Cash Accumulation	+20,000	+20,000	+20,000

cash accumulation equal to the original capital outlay. Payouts for each project are as follows:

Payout (I) =

$$\frac{20,000}{4,000} = 5 \text{ years, Payout (II)} =$$

$$\frac{20,000}{7,000} + 6,800 + \text{etc.} = 2.9 \text{ years,}$$

$$\text{Payout (III)} = \frac{20,000}{400} + 1,200 + \text{etc.} = 7.1 \text{ years.}$$

Accounting rate of return can be calculated several ways. First, by using the ratio of average yearly cash accumulation to original outlays, which would give in this case the same rate of return for each project,

$$\text{or: (I, II, III)} \quad \frac{4,000}{20,000} \times 100 = 20\%$$

Second, by using the ratio of average yearly cash accumulations to one-half original outlay. For I, II, and III, this

$$\text{would be } \frac{4,000}{10,000} \times 100 = 40\%.$$

Other ways would be to deduct straight line depreciation for capital recovery from the yearly cash accumulations before figuring the return. For examples, in the problem above, it would be $\frac{4{,}000 - 2{,}000}{20{,}000 \text{ or } 10{,}000}$

This gives returns of 10 percent and 20 percent, respectively.

The discounted cash-flow method is a rate-of-return calculation expressed as a percent of the unrecovered portion of the investment. This method has a built in allowance for capital recovery. The rate of returns for the above projects using this method are: for (I) 15.9 percent; for (II) 25.4 percent; and for (III) 11.2 percent. To illustrate the method of calculation, let's use project II. All factors are obtained from a continuous interest table (see Figure 2).

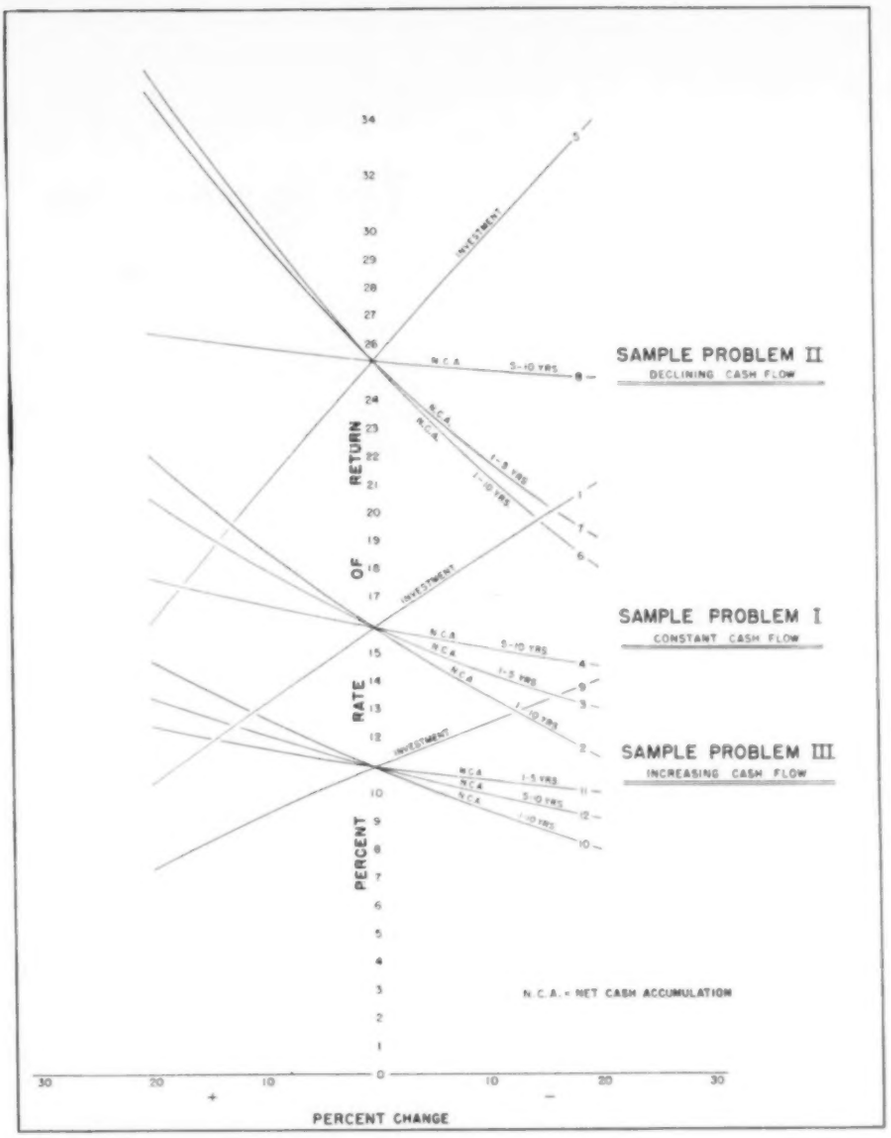


FIGURE 3

Evaluation of three yardsticks. Now, how well does (1) payout, (2) accounting rate of return, and (3) discounted cash flow serve as a yardstick?

Payouts have the advantage in that everybody has become accustomed to their use. In those cases, where the economic life is the same, a fairly accurate selection of the most attractive opportunities can be made. They can serve as a rough indicator to determine if a more refined project analysis should be made. However, their disadvantages are many.

1. They stress the cash flow only during the breakeven period, and neglect any cash flow during the rest of the project life. Except for non-profit organizations, companies are not established just to break even, but to make some profit.

2. They do not provide an accurate index for ranking projects which have different economic lives. Since a company is likely to have many projects under consideration at a particular time, this factor is very important.

3. They discourage the use of trends and cash flow predictions over the project life. Neglecting trends and predictions can cause a premature disposal of facilities, an improper design, a lack of project flexibility, and large amount of modifications after installation.

4. They neglect the time value of money. After all, a dollar received or spent today is worth more than a dollar several years hence. A dollar today can be reinvested or used for current obligations.

5. They are not sensitive to changes in the cash flow pattern. Figure 3

TABLE 2

		TRAIL RATE R = 22%		TRIAL RATE R_1 = 27%	
		Factors	Value (V)	Factors	Value (V_1)
0	−20,000	1.0000	−20,000	1.0000	−20,000
0-1	+ 7,600	.8975	+ 6,821	.8763	+ 6,660
1-2	+ 6,800	.7202	+ 4,897	.6690	+ 4,549
2-3	+ 6,000	.5781	+ 3,469	.5107	+ 3,064
3-4	+ 5,200	.4639	+ 2,412	.3898	+ 2,027
4-5	+ 4,400	.3723	+ 1,638	.3975	+ 1,309
5-6	+ 3,600	.2987	+ 1,075	.2271	+ 818
6-7	+ 2,800	.2397	+ 671	.1734	+ 486
7-8	+ 2,000	.1923	+ 385	.1323	+ 265
8-9	+ 1,200	.1544	+ 185	.1010	+ 121
9-10	+ 400	.1239	+ 50	.0771	+ 31
	.....	....	+ 1,603 (V)	....	− 670 (V_1)

$$\text{Rate of Return} = R + \frac{V\,(R_1 - R)}{V\text{-}V_1} = 22 + \frac{1{,}603\ (27\text{-}22)}{1{,}603\text{-}(-670)} = 25.5\%$$

shows the payouts for problems I, II, III, if certain changes occur in the cash flow pattern.

6. They cannot indicate whether minimum earning levels have been obtained.

Accounting rate of return does measure the earning power of a project. There are many variables which must be reconciled and accepted before its use is worth while. Capital recovery can be provided for, and an indication can be obtained, as to whether minimum earnings level has been met. The use of this method makes it difficult to determine the relative attractiveness of projects.

Also, it isn't very sensitive to changes in cash flow and does not consider the time value of money. Another difficulty is in the use of averages. There are many types of averages. These averages vary, depending on the time period considered. For example, the average investment tie-up, using straight line recovery, over a five-year period is .6 of the original investment. For a ten-year period this average is .56.

Discounted cash flow overcomes these disadvantages by concentrating on the project's lifetime earnings, allowing for capital recovery, and by weighing the time value of money. Because of its sensitivity and direct measure of earnings, it allows for the accurate ranking and selection of projects. Minimum earnings level can be established in terms of percent on the investment. By projecting the cost of capital—what the company must pay to attract the investors dollars—management can raise or lower the minimum accepted return. Figure 4 shows the sensitivity to changes in cash flow.

Conclusions. As a rule, payouts have to be accompanied with supplementary data before a decision can be made. The many variables associated with the accounting rate of return present quite a problem of interpretation. Both methods are more commonly understood and used than discounted cash-flow. Most people are not too familiar with discounted cash flow; however, this method is the more desirable one because it emphasizes all aspects of a given capital outlay. —**The End**

Use Your Engineers To Meet the 'Shortage'

Here's an answer that suggests time clock punching and an hourly wage basis are out of the question. The engineer is a professional man and wants to be treated as such.

By EMMETT G. JACKSON
The Lummus Company, Houston

EVERY DAY we hear more about the shortage of engineers. Your job—utilize the ones you have!

Many companies are actually hoarding engineers—that is, they have competent engineers whose abilities are not being used to their fullest extent. These engineers are being used as draftsmen, clerks, and other non-engineering jobs that could be turned over to non-technical personnel. Engineers seem to lose perspective and morale when kept in jobs which can be done by people with less training. Let us see how we can get the most efficiency out of our engineers.

Engineers Punch Time Clocks?—In general, engineers are extremely individualistic and fiercely ambitious. They should not be typed with non-technical personnel because their functions demand concise, original thinking. They should not be required to punch time clocks, nor should they be paid on an hourly basis. Engineers do not readily take to unions because they had rather stand on their own ability than to share collectively in group benefits and become stagnated. In short, engineers are professional people and should be treated as such.

Engineers should be hired by engineers. Many companies make the mistake of leaving all the hiring up to their personnel department. A few years ago, the author, a civil engineer, was applying for a position with a large company. Pictures of reinforced concrete and structural steel buildings designed and constructed by the company were hanging on the walls, mute evidence of their previous projects. The personnel manager dismissed the application with a curt "we do not use civil engineers." Not until some time later did the author realize the personnel manager did not know that civil enginering encompassed structural design as well as surveying. Only an engineer can properly evaluate the technical knowledge and ability of an individual after a short interview, and even he gets "taken in" occasionally by a smooth-talking "snow artist."

Engineers should have engineering titles. True, the term "engineer" has been greatly abused by the layman, but it still adds dignity to the company as well as the engineers when qualified personnel are referred to in a professional manner. It gives a man a feeling of pride to be associated with a company as an engineer rather than a checker, or squad boss. Also, sub-professional draftsmen have more incentive in their work when they realize that their future promotions will rank them with engineers.

Most companies encourage continued studies because it indirectly benefits the company as the engineer increases his knowledge. Where possible, full use should be taken of neighboring university facilities for training and consultation. If university facilities are not available, special courses can be sponsored by the company itself, and conducted by qualified engineers within the organization.

Many companies find it helpful to encourage their enginers to be-

come registered, and to participate in the activities of professional organizations. Time off should be granted for registration examinations, professional meeting and seminars.

Money's Role for the Engineer—Some executives feel that an engineer's pre-occupation with money is a something-for-nothing attitude, and that it indicates the lack of professional attitude. However, men do not feel like professionals when they are paid less than skilled labor. On the other extreme, some companies depend on large salaries and fringe benefits to keep their engineers satisfied. A recent survey among engineers brought out the fact that they consider their future advancement and opportunities of greater importance than the items mentioned above.

Most engineers are concerned with how their employers like their work. Management should have a fixed engineer-evaluation system that is fully understood by their employes. Thus, the engineer's mind is at rest as far as his personal interest is concerned, and he can concentrate on the problems of his job.

Communications Most Important—A major factor in the poor utilization of engineers is undoubtedly the lack of good communications between management and engineers. Management sometimes claim that engineers feel they are working in a research laboratory rather than for a company. On the other hand, engineers sometimes complain that the companies are exploiting them. Obviously there is simply a misunderstanding that can be rectified by better communications. It is quite apparent that management should take the initiative since they have more to gain.

Communications serve the two-fold purpose of informing the individual about the company policies as well as his future with it. The engineer, realizing that his personal advancement is dependent upon the financial progress of the company, is essentially ambitious for it. Too often the engineer sits in a corner doing his work and gets only a worm's-eye-view of the project. In order better to perform his duties, he should be given an overall perspective of the project. When properly informed about his company, the engineer develops a deep sense of loyalty. Having a feeling that he belongs with an organization and that he is accomplishing something rather than just doing a job, the engineer thereby increases his efficiency.

Regular engineering conferences and seminars are used successfully in management-enginering communications. The most common method is the direct line of supervision. However, that is not enough. News letters have proven to be an effective method of keeping engineers informed. As a professional group, engineers are best appealed to on an individual basis. Thus, seminars and special forums are most effective because of the individual participation of the personnel.

Never in our history have engineers been in such great demand. With our expanding economy and defense efforts, we must make the most of what we have. Better utilization of engineers means more efficiency, less turnover, and an end to the so-called "engineer shortage."

About the Author

EMMETT G. JACKSON is a senior design engineer in The Lummus Company's Structural department. He joined Lummus in 1951, after working for the Texas State Highway Department, first in the field and then in the Bridge division. He is a graduate of the University of Texas, where he received a degree in civil engineering in 1947.

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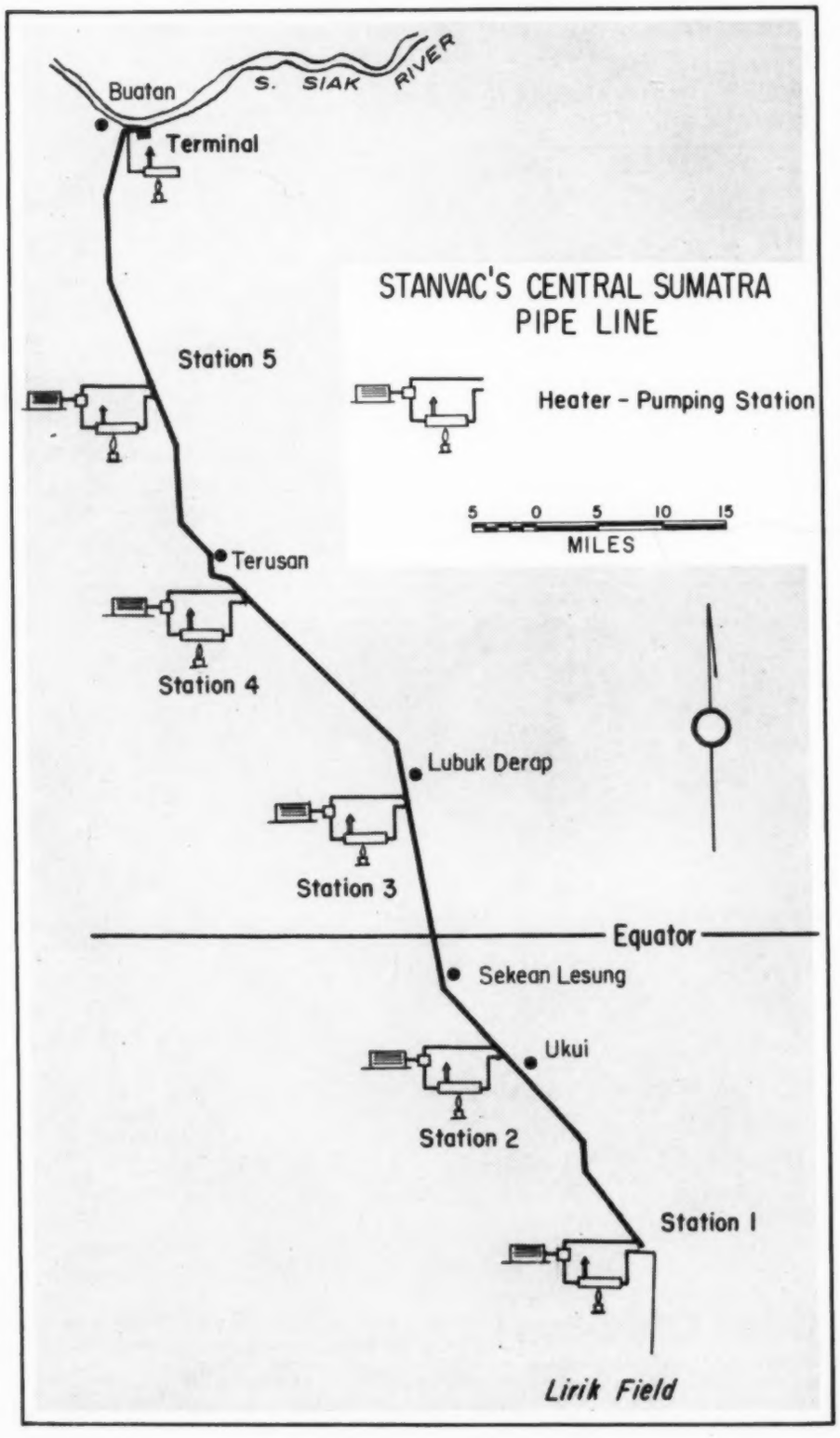
Good Old Days? "Horsepower" in operation on a river crossing. This is the way they made the approaches in the 1920's. No giant earth-movers or draglines, only horses and strong backs. The team and slip moved about four cubic feet of dirt each load. It would take ten such teams to move as much dirt in a day as a modern bulldozer can move.

Arctic Pipelining on the Equator

Stanvac's engineers have tried every trick in the book to handle the 105° F. pour point crude from Central Sumatra's Lirik field. Best solution is to heat the oil to to 153° and reheat every 18 miles up the line.



ENGINEERS WITH Standard-Vacuum Petroleum Company have come up with a solution to the problem of moving the 105° F. pour point Lirik crude from Central Sumatra. To get the "fluid" moving in a pipe line, they will heat it to a temperature of 153° F. and reheat it at heater-pump stations every 18 miles up the 88-mile line from the field to the Buatan terminal on the Siak river. A tracing line will carry hot water and steam to "thaw" the 8-inch line after shutdowns.

Lirik crude has been a transportation headache to Stanvac pipeliners since the field was discovered in 1939, except for one period. During World War II the Japanese worked out their solution to the transportation problem. They cooled wicker baskets in the river, filled them with hot oil, allowed it to harden and then floated them down the Kuantan River lashed together as a large raft.

Stanvac's engineers had tried almost every scheme but the wicker baskets. First thought was to blend the crude with naphtha, 35 percent solvent and 65 percent oil. The need for a large diameter pipe line plus a topping plant and solvent return line ruled this method out. Emulsification with water was considered, but the oil formed a virtually permanent emulsion which could not be broken commercially.

Thought was given to moving the crude through the line in a solid plug floating inside a sleeve of water. Other ideas considered were vis-breaking installations, and electrical heating of the pipewall, but all were ruled out as impractical or uneconomic. Tests with a short section of line (9 miles), fitted with various heating units and defrosting lines indicated that heating the oil at intervals along the line would be the best answer.

To keep the oil moving in the pipe line, Stanvac engineers will heat the

oil to 153° F. Experiments indicate that the oil will cool down nearly to the pour point in about 18 miles of pipe line flow so four heating units will be installed at pumping stations at 18 mile intervals up the line to reheat the oil to 153° F. A fifth heating-pumping installation will handle the crude at the Buatan terminal on the Siak river.

When the new pipe line is completed in 1958, 20,000 to 32,000 barrels are scheduled to move from the Buatan terminal daily by tanker down the 56-mile waterway to the sea. At present, 2000 barrels of the Lirik crude are shipped down the Kuantan River in shallow draft, coil-heated barges to deep water facilities, and then on to Stanvac's Sungei Gerong refinery in southern Sumatra.

Lirik wells flow normally under about 700 pounds per square inch reservoir pressure. However, when the wells are shut-in the high-paraffin crude solidifies in the top 500 feet of the tubing. Hot-water pipes are incorporated into the upper third of the string and in the wellhead. Steam and hot water tracing systems heat all gathering lines.

Here is a pipe line paradox, in a jungle where natives have to fight off heat rash and hordes of insects while clearing the right-of-way, stations are being designed to handle oil as if they were going to operate in Northern Canada. In spite of transportation difficulties, the low sulfur content and high component yield of the Lirik crude during catalytic cracking promise to make it worth the effort.

Indonesian workmen start cleaning right-of-way through the dense jungles of Central Sumatra. The 88-mile line will carry heated crude from the Lirik field northwest across the Equator to a terminal on the Siak river.

Pump stations will be built at intervals of 18 miles along the line. Crude cooled while flowing through the line will be reheated to about 153° F. and pumped by these diesel-powered units.

Photos courtesy Standard-Vacuum Oil Company.

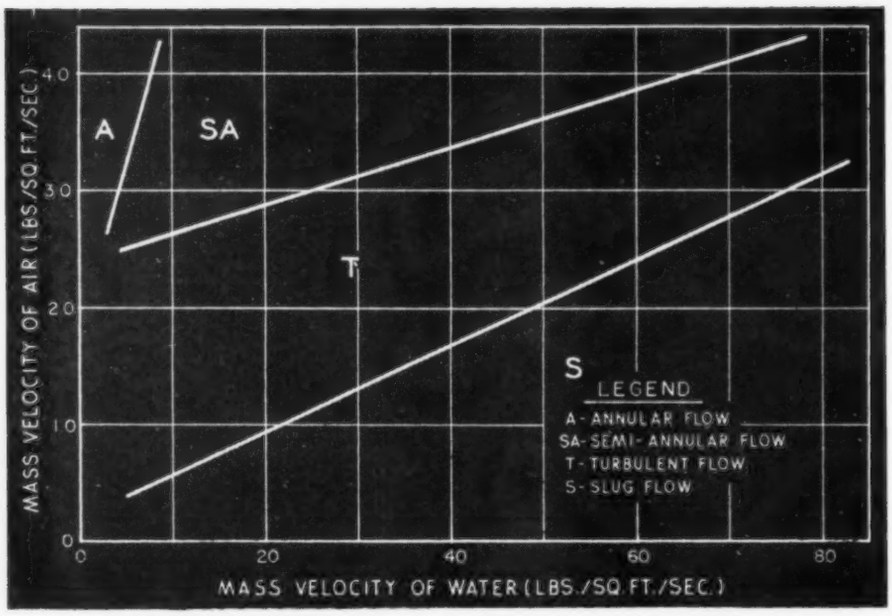


FIGURE 1—Flow pattern for water-air mixtures in vertical two-phase flow.

Report on Two-Phase Vertical Flow

Extensive tests provide more information on pressure losses and flow patterns involved in such systems.

By W. C. GALEGAR*, W. B. STOVALL, and R. L. HUNTINGTON
University of Oklahoma, Norman

ALTHOUGH THE co-current vertical upward flow of gas and liquid has been carried out for many years, there still remains a need for more experimental data in order better to understand the flow mechanisms under varying conditions of mass flow rates and gas-liquid ratios.

Important applications of two-phase flow are found in mixed vapor-liquid feed to chemical process equipment, air lift pumps, and in the simultaneous pipe line transportation of oil and natural gas. Two-phase flow is frequently found to be unavoidable in chemical process equipment such as evaporators, heat exchangers and fractionators.

Comparatively little information is presently available regarding the prediction of pressure drops where two-phase flow occurs. It is known that larger energy losses are encountered in two-phase flow than might be expected in single-phase flow. This phenomenon of increased energy loss has been attributed to irreversible work losses of the gas acting on the liquid and the reduced effective area of the pipe due to the presence of two components flowing simultaneously in two separate phases. The mechanisms involved in two-phase flow are still obscure and a satisfactory method of predicting pressure drops is needed.

This study was undertaken with the object of extending the available information on pressure losses in two-phase vertical upward flow in conjunction with visual observations of the flow patterns involved.

Vertical two-phase flow was used as early as 1797 in the form of an air-lift pump invented by Carl Loscher, a German engineer. The principle is now extensively used for lifting water.

The first major application of two-phase vertical flow occurred in 1927, in the Seminole, Oklahoma, oil fields, where oil was successfully produced by means of the gas-lift principle.

Uren,[8] Gregory, Hancock, and Feskov, at the University of California in 1930, pumped mixtures of compressed air and oil through a two inch diameter section of oil-well tubing 41.4 feet in height. The relationship between a pseudo-friction factor and the Reynold's number was plotted. This method required the computation of an equivalent viscosity of the gas-liquid mixture.

In 1929, Versluys[9] presented a mathematical analysis of two-phase flow as applied to the theory of flowing oil wells.

Gosline,[4] in 1936, determined efficiencies of an air lift pump using water and petroleum oils. The effect of varying gas-liquid ratios and flow rates in a vertical 1.05 inch diameter Pyrex tube 25.56 feet in height was investigated.

Cromer,[3] in 1936, investigated the performance of an air-lift pump at the University of Oklahoma. Mixtures of water and air flowing through a two-inch vertical pipe 98 feet in height was studied. By visual techniques Cromer stated four types of two-phase vertical flow may exist:

1. Liquid dispersed with gas.
2. Gas dispersed with liquid.
3. Pistons of gas interdispersed with slugs of liquid.
4. An annular flow of liquid along the tubing wall surrounding a core of gas relatively free of liquid.

Cromer investigated the effect of submergence, air-water ratio, and fluid temperature on flow characteristics. His results indicated that the rate of liquid flow was a mathematical function of the submergence.

Boelter[2] and Kapnar investigated, in 1939, two-phase flow in one-half and three-quarter inch metal pipes. They reported the pressure gradient for two-phase flow was a logarithmic function of the air flow rate for constant gas-liquid ratios.

Bergelin,[1] Kegel, Carpenter, and Gazely used an 11-foot section of one inch internal diameter copper tubing with pressure taps set at one foot intervals. They studied the effect of air flow rate upon the pressure drop with the liquid rate as the parameter. Their results indicated that the increase in air velocity due to the liquid present could only account for a small fraction of the pressure drop increase due

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to the presence of liquid. A Fanning friction factor was plotted against a Reynold's modulus based on the inside tube diameter and the gas phase. The results apparently indicated that the liquid film acted as a very rough pipe wall for annular flow conditions.

In 1949, Martinelli and Lockhart[5] presented a correlation that enabled the prediction of pressure drops to within plus or minus about thirty percent.

Poettman[7] and Carpenter in 1952, discussed multiphase flow in vertical flow strings. They offer a method of predicting bottom hole pressure and pressure traverses of flowing oil wells based on surface data. The method is based on field data from 49 flowing oil wells and gas lift wells. Results were correlated by means of a modified Reynold's modulus plotted against a modified friction factor based on the Fanning equation. In all cases flow was assumed to be turbulent enough to render the effects of viscosity negligible.

From a survey of the literature presently available, it is apparent that no completely satisfactory means of computing pressure drops in two-phase vertical flow systems has yet been presented. The study of the problem is possessed of many inherent difficulties which frequently make accurate data difficult to obtain, especially in the region of slug flow.

This investigation presents experimental data on the performance of kerosine-air and water-air systems in two-phase vertical upward flow using two test sections of different size but having the same ratio of diameter to height. A tentative correlation is presented in conjunction with visual data on the flow patterns involved.

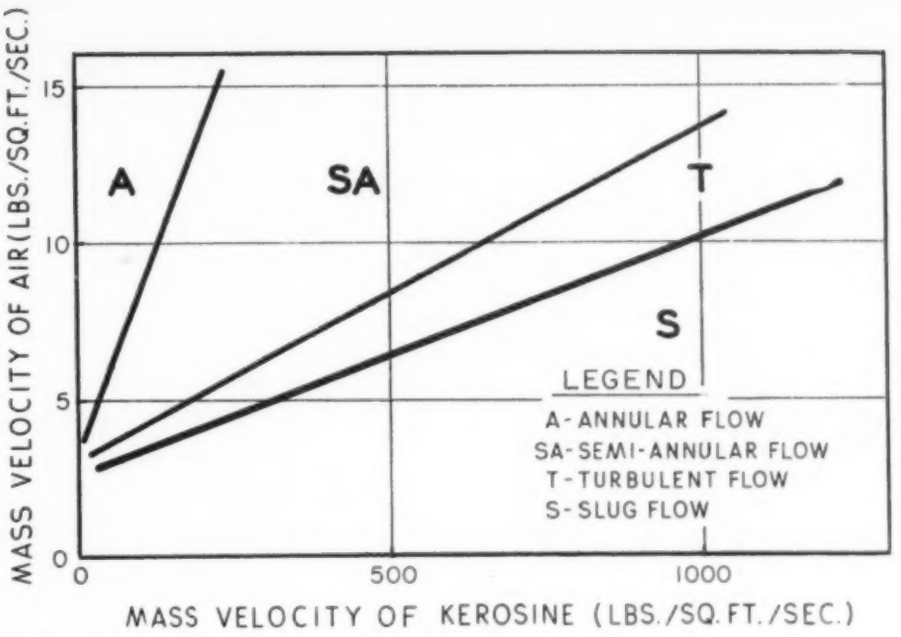

FIGURE 2—Flow pattern for kerosine-air mixture in vertical two-phase flow.

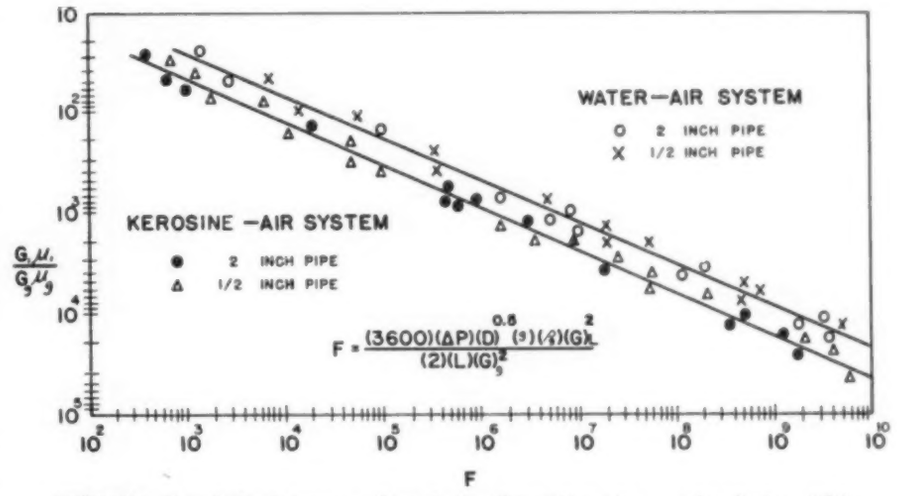

FIGURE 3—Correlation between a dimensionless flow ratio and energy loss factor—"F."

Description of apparatus. The apparatus required for this visual study consisted of two vertical clear plastic sections of tubing, ½ inch by 19 feet and 2 inches by 72 feet respectively. In the case of the two-inch tubing, the bell joint at the end of each 20 foot section was cut off so that the straight tubing sections could be cemented with smooth internal butt-joints. Tetrabromethane proved to be the most satisfactory solvent for dissolving chips of plastic into a liquid cement for the joining of the tubing sections. The principal support for each tubing assembly was located at the top of each section so that any contraction or expansion would allow the tubing to hang in a straight vertical position without strain or buckling.

Air volumes were measured at the inlet of each section and the liquid streams were weighed at the exits. In order to obtain a quantitative measure of the slippage in each section, quick-closing valves were installed at the bottom and at the top of the two sections. By suddenly shutting off the flow, the ratio of the liquid to gas quantities "in situ" (in place) could be readily determined. In all cases the ratio of liquid to gas was greater "in situ" than the flowing ratio.

Pressure-drop data were taken by means of Bourdon-tube gages which were calibrated to ¼ pound per square inch increments.

Discussion of Experimental Results. Data pertaining to the physical behavior of the systems in simultaneous two-phase vertical upward flow were recorded in conjunction with visual observations of the flow patterns associated with each run.

Five principal flow patterns were encountered in visual observations of the systems in operation. As gas is slowly introduced into an upward flowing liquid stream, the following sequence of flow patterns will occur as the gas rate alone is increased:

1. Aerated flow, which may be defined as a small amount of gas dispersed, in a relatively large amount of liquid, in the form of small bubbles; in this type of flow the gas phase contributes relatively little lifting effect to the liquid phase. As the

amount of gas flowing is increased the lifting effect becomes more pronounced, and the system approaches a state of incipient slug flow.

2. Slug flow occurs when the gas phase forms rising pistons of gas which lift slugs of liquid. As the gas piston rises, considerable liquid slippage around the piston occurs, resulting in a loss of efficiency when operating as a gas lift. Increasing the gas rate causes the liquid slugs to be filled with small bubbles of gas and also increase the length and the rapidity of travel of the slugs. Cromer[3] stated that the two-phase system operated most effectively as a gas lift in this region of longer gas pistons. Further increase in the gas rate results in a breaking up of the pistons and slugs, causing the system to pass into the next major flow pattern.

3. Turbulent flow occurs when the gas and liquid phases are in a violently agitated mixture of gas and liquid evenly dispersed throughout the test section. The liquid slugs and air pistons are completely broken up and the two phases stay well mixed with the possible exception of an occasional rapid slug of liquid traveling up the test section at boundary flow regions.

4. A further increase in the gas rate causes the two phases to separate again and the system passes into the semi-annular region. The semi-annular region is actually a broad transition region, between the turbulent and the annular regions, characterized by the appearance of an annular liquid film surrounding a central core of gas. However, there are small amounts of liquid occasionally passing across the tube and entrained in considerable quantity in the central gas core. The transition between the semi-annular and annular regions is very broad and the characteristics of the two patterns are quite similar.

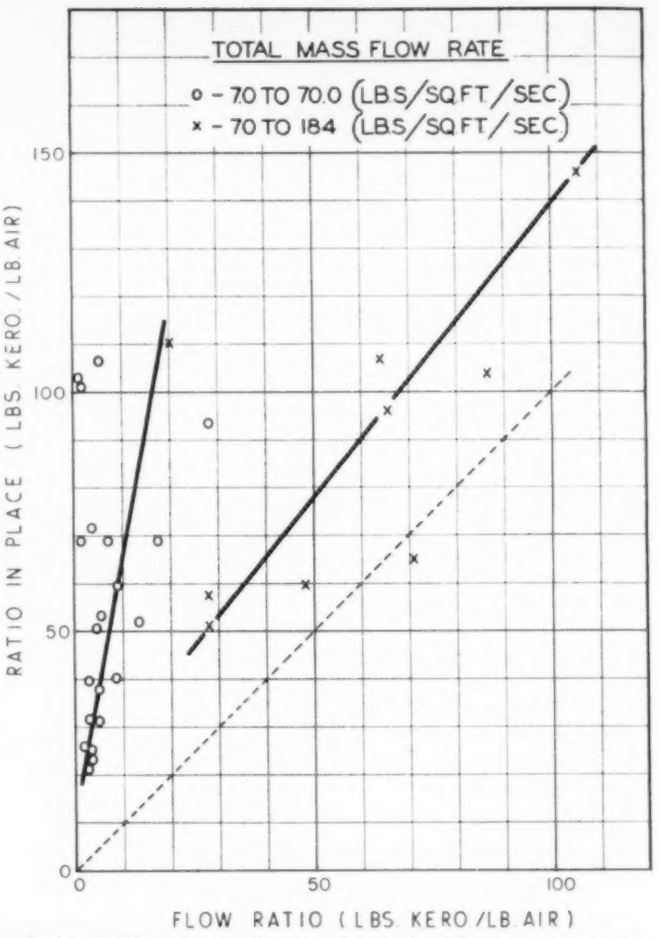

FIGURE 5—Kerosine-air flow in 2-inch by 72-foot vertical pipe, comparison of ratio in place to flow ratio.

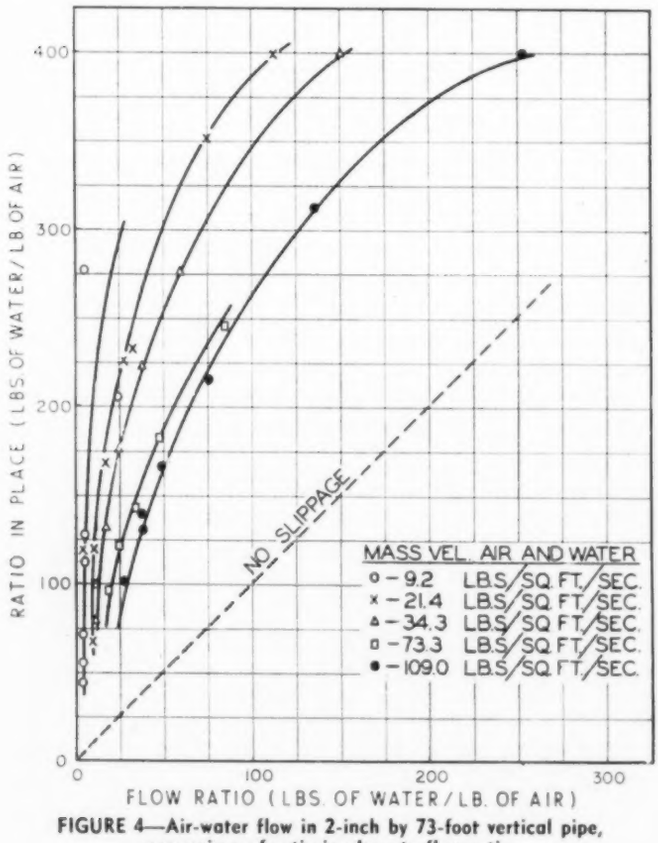

FIGURE 4—Air-water flow in 2-inch by 73-foot vertical pipe, comparison of ratio in place to flow ratio.

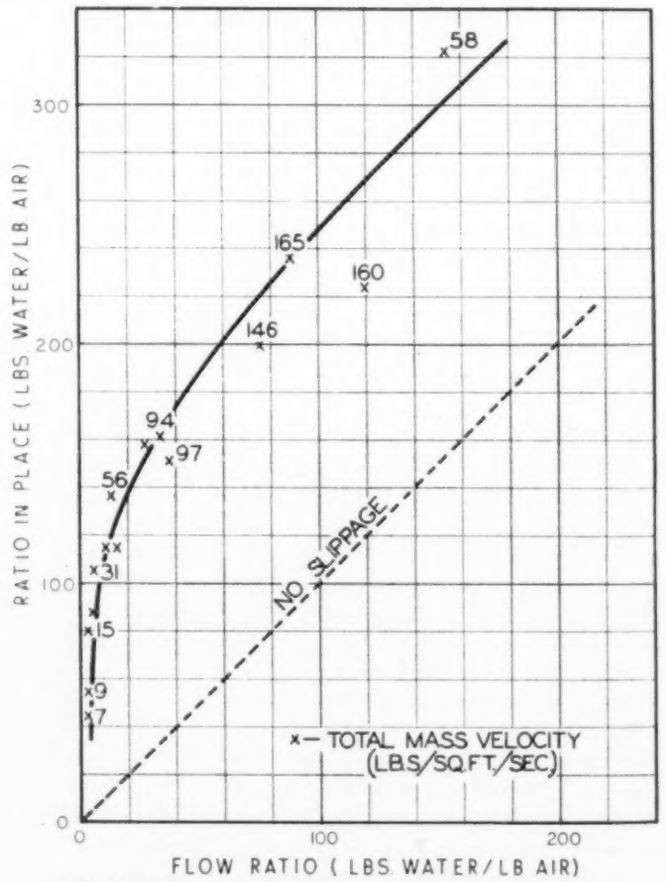

FIGURE 6—Air-water flow in ½-inch by 19-foot vertical pipe, comparison of ratio in place to flow ratio.

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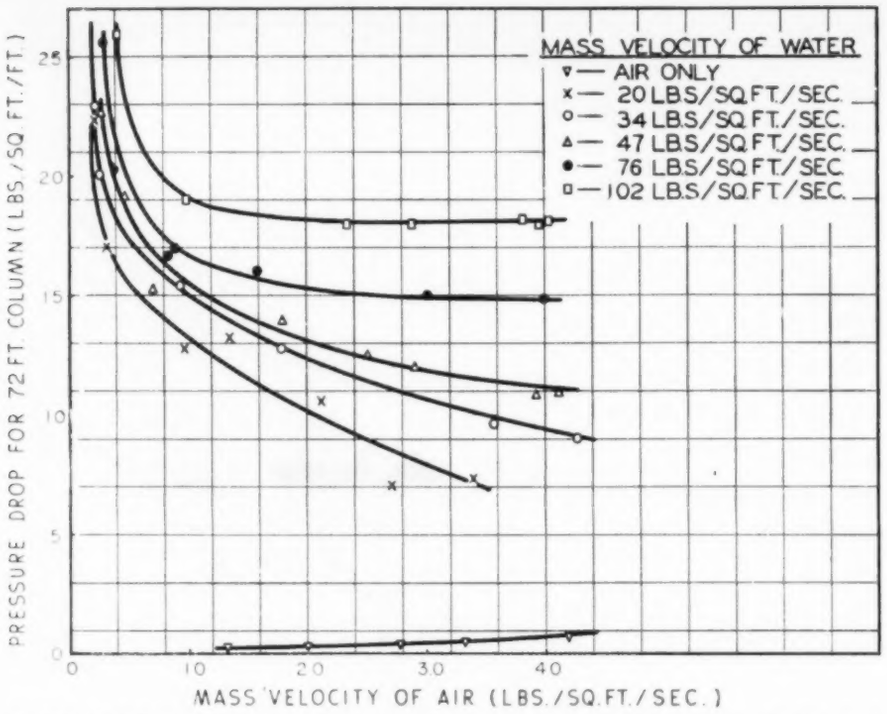

FIGURE 7—Relationship of pressure drop in 2-inch by 72-foot column to mass velocity of air for several water flow rates.

NOMENCLATURE

S — slug flow
T — turbulent flow
SA — semi-annular flow
A — annular flow
D — diameter of test section, ft.
G_l — mass rate of liquid flow, lbs./sec./ft.^{2}
G_g — mass rate of gas flow, lbs./sec./ft.^{2}
g — gravitational constant, ft./sec.^{2}
L — length of test section, ft.
M — molecular weight of air
N — lb. moles of air
P_b — base pressure at lower pressure tap, psia.
P_t — pressure at top pressure tap, psia.
dP — differential pressure across the test section, psi.
R — gas constant, psia, cu. ft./lb.-mole, °R
T_m — meter air temperature, °R
V_m — meter air rate, cu. ft./sec.
P_m — meter pressure, psia.
Z — air compressibility factor
P_g — air density, lbs./cu. ft.
P_a — average air pressure in column, psia.
T_a — average column air temperature, °R
F — energy loss factor, lbs.^{2}/ft.$^{4.5}$
μ_l — kerosine viscosity, centipoises
μ_g — air-viscosity, centipoises

5. At very high gas rates practically all liquid, with the exception of small amounts of entrainment, flows annularly up the tubing walls around the core of gas. In this type of flow Bergelin[1] attributed the increased energy losses found in two-phase flow to the rough pipe wall effect of the annular liquid film. Any subsequent increase in the gas rate will result in thinning the liquid film.

Figures 1 and 2 present the major flow patterns encountered:

The boundaries indicated in these two flow-pattern figures may be misleading as the transition from one region to another is a gradual one for both two-phase systems which were studied.

The pressure drop data were found to correlate the best by plotting a correlation factor based on a modification of the Fanning equation against a dimensionless flow ratio of the two phases flowing. The results of plotting F against the flow ratio $G_l\mu_l/G_g\mu_g$ are presented in Figure 3. The correlation represented the data to within approximately ± 23 percent.

Evaluation of errors. Fluid flow rates, determined by weighing the kerosine and by metering the air were considered accurate to approximately 5 percent. The effects of evaporation, kinetic energy changes, and energy changes due to extraneous sources, were considered negligible for computational purposes.

The flow was assumed to be isothermal in nature and fluid temperatures were read to 0.5 F. Average temperatures of the flow stream were based on entering and exist kerosine temperatures.

Pressure drops were calculated by averaging maximum and minimum deflections of the Bourdon gauges. In the case of slug flow, pressure fluctuations ranged as high as 20 percent of the mean pressure differential across the test section. Other regions of flow produced considerably smaller gage fluctuations than the region of slug flow.

Slippage measurements. By comparing the mass flow ratio with the ratio "in situ" of liquid to gas, a relative efficiency curve may be shown for each total mass flow rate. From Figures 4, 5 and 6, it is readily seen that the higher mass flow rates approach the ideal type of flow represented by the 45° line where the "in situ" ratio is the same as the flow ratio. Although the data are somewhat scattered, it is felt that the trends are sufficiently definite to be of some quantitative value.

Over-all pressure drop vs. gas flow rate. Figure 7 presents an interesting relationship which exists between the pressure drop from the bottom to the top of the 72-foot section of two-inch tubing for various air-water ratios and flow rates. For the high water rates there is a rapidly declining pressure drop with increasing aeration of the flowing stream until a mass velocity of about 150 pounds per square foot per minute of air flow is reached after which the pressure drop remains substantially constant.

Original presentation was before the American Institute of Chemical Engineers, St. Louis.

ACKNOWLEDGMENT

The authors wish to express their sincere appreciation for the generous financial support which Magnolia Petroleum Company, The Dow Chemical Company and Maloney-Crawford Tank and Manufacturing Company have given to this experimental study.

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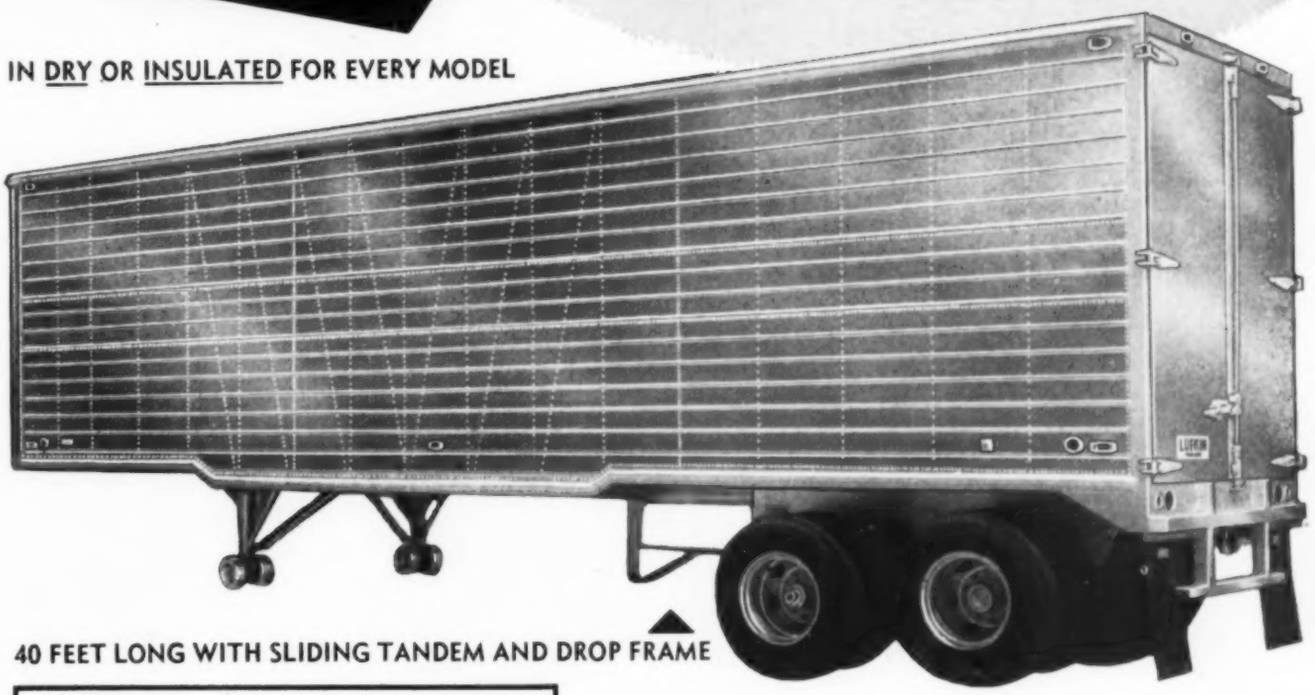

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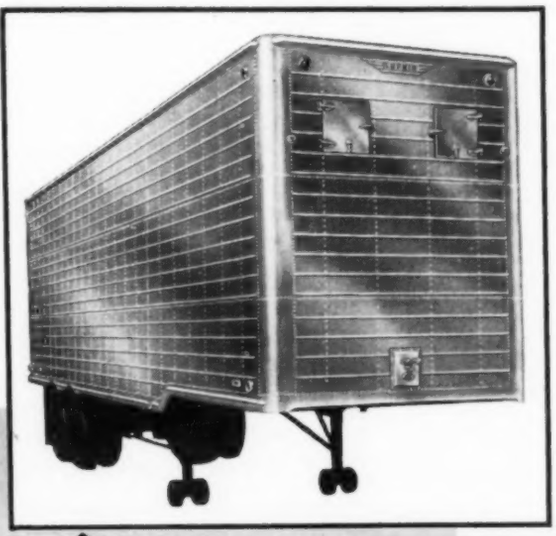

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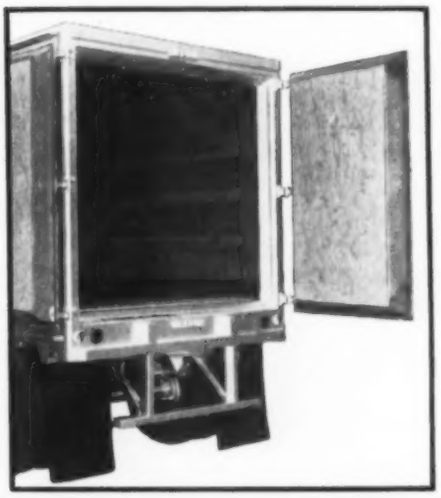

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What Is the Economical Size of Conductors

Here is a simple method of calculation using three factors—load, mechanical strength and economics.

By HERBERT ARGINTAR
James P. O'Donnell, Engineers, New York City

THERE ARE three factors to be used in sizing electrical conductors—(1) the load to be supplied, (2) mechanical strength required for the particular loading area and (3) economics.

The last consideration, economics, is generally overlooked as regards the conductor in relation to its load. Yet, it was one of the first criterion to be mathematically analyzed. The "formula" results from studies undertaken by Kelvin, and is herein presented for copper conductors. The same approach can be applied to a conductor of any material.

Kelvin's Law as stated is:

The most economical size of transmission line conductor is that for which the annual energy cost of line loss equals the copper cost.

The proof of this is demonstrated as follows:

Proof:

K_1 = Invariable Fixed Charges which are independent of the circuit size. (Poles, hardware, etc.)
K_2 = Variable Fixed Charges which are proportional to the circuit size; i.e., copper size or area. (Insurance, interest, depreciation, etc.)
K_3 = Constant representing the energy cost of the line; i.e., the I^2R loss. It is inversely proportional to the circuit size.
A = Conductor cross-sectional area.
C = Total annual cost of operating the line.

1) $C = K_1 + K_2(A) + K_3/A$

2) $\frac{dC}{dA} = 0 + K_2 - K_3/A^2$, and setting $dC/dA = 0$.

3) $A = \frac{(K_3)^{1/2}}{(K_2)}$, which indicates the economic conductor size.

3a) $K_2(A) = K_3/A$, which equates energy cost to copper cost.

From the above, it is possible to derive a formula expressing conductor size in terms of energy and copper costs. The "formula" is produced as follows:

Development of Formula:

t = Hours of operation per year.
C_e = Cost of energy @ ¢/Kw-Hr.
R = Resistance of annealed copper $\left(= \frac{(10.6)\,L}{A}\right.$, where L = Length of line.$\left.\right)$
C_c = Cost of copper @ ¢/lb.
W = Weight of annealed copper (= 3.03 × 10.6 lb./CM-ft.)
V = Volume of copper
F = Fraction for Fixed Charges (Amortization) (= AL)
I = Load current

1) $\frac{K_3}{A} = \frac{I^2\,Rt.\,C_e}{1000} = \frac{10.6 \cdot L \cdot I^2\,t \cdot C_e}{1000 \cdot A}$ Energy Cost

2) $K_2A = W \cdot V \cdot C_c \cdot F = 3.03 \times 10^{-6} \cdot A \cdot L \cdot C_c \cdot F$ Copper Cost

Equating (1) and (2):

3) $10.6\,L \cdot I^2\,t.\,C_e = 3.03 \times 10^{-3} \cdot A \cdot L \cdot C_c \cdot F$

3a) $A = 59 \cdot I \cdot \left(\frac{C_e \cdot t}{C_c \cdot F}\right)^{1/2}$ Copper size required.

In the event that a load is cycled, or varies over a period of time, the load current may be expressed in terms of the effective value of all the individual loads:

3b) $A = 59\left(\frac{C_e}{C_cF}\right)^{1/2} \cdot (I_1^2t_1 + I_2^2t_2 + \text{etc.})^{1/2}$ For varying currents.

Comment: Note that length of line, line voltage, etc., is immaterial. The prime concern is copper economics, not electrical characteristics. The use of the formula may be demonstrated by means of a typical problem.

Problem: Determine the economic cable size required for a 96 ampere load operating 365 days per year, 8 hours per day.

Given: Energy costs $0.00875 per Kw-hr. Fixed charges are 23 percent (Investment for 5 years at 3 percent and insurance, taxes, etc.) Copper costs $0.47 per pound.

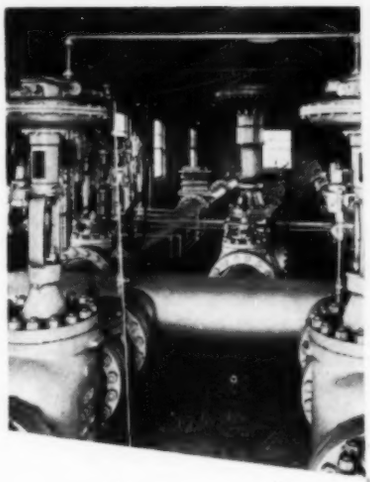
Solution:

$$A = (59) \cdot (96) \cdot \left(\frac{0.875 \times 365 \times 5}{47 \times 0.23}\right)^{1/2} = 68{,}800 \text{ C. M.}$$

A #2 AWG, with a cross-sectional area equal to 66370 C. M. is the most economical choice. However, the other previously mentioned factors must also be considered before actual selection is made. —**The End**

About the Author

HERBERT ARGINTAR is an engineer for James P. O'Donnell, with duties which involve specifications and procurement, design and engineering for refinery electrical service and general utilities. With the company five years and formerly engaged in various chemical and industrial projects, Argintar also has served three years as a member of the electrical-engineering staff at Pratt Institute, and now is preparing two textbooks for the institute, one on D. C. and the other on A. C. machinery. An electrical-engineering graduate from City College of New York, he has completed part of the work on a mechanical-engineering degree from New York University. He is a professional engineer in New York.



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Pipe Line Construction

—15—How to calculate the contraction or expansion of a pipe line resulting from temperature changes and estimate the allowances for slack in loops.

Steel pipe contracts or expands approximately 0.8 inch per 100° F. temperature change for each 100 feet of pipe. For construction in the U. S., slack is not normally needed in welded lines for contraction or expansion unless abnormal variations are encountered. However, slack is often provided near road crossings where the pipe may have to be lowered at some future time.

$$\text{Contraction} = 0.8 \times \frac{\text{length of pipe (feet)}}{100} \times \frac{\text{temp. change (°F.)}}{100}$$

Example: Calculate the amount a 1000-foot section of pipe line would contract if laid at a temperature of 100° F. and cooled to a low of 0° F. during winter operation. (Assuming the line were free of soil or other resisting loads.)

$$\text{Contraction} = 0.8 \times \frac{1000}{100} \times \frac{100}{100}$$
$$= 0.8 \times 10 \times 1$$
$$= 8 \text{ feet}$$

Large temperature changes may arise on exposed line or in lines downstream from compressor stations.

When slack is desired in a line, the amount of sag or rise needed may be estimated quickly. To provide for 0.8 inch of movement longitudinally along the pipe, a sag of 21 inches would be needed in a 100-foot loop. For a 150-foot loop, 31 inches are necessary. Such slack put into the line at time of construction might allow for lowering the pipe under roadbeds without putting excessive stress upon the pipe.

Location of overbends, sags, and side bends should be considered when laying slack loops. When loops are placed, parts of the line should be backfilled to serve as a tie-down. Loops should be lowered during the coolest part of the day when the line is the shortest. After lowering-in, sags should rest on the bottom of the ditch; overbends should "ride high." Side bends should rest on the bottom of the ditch and against the outside wall. The line should be lowered so that all sections of the pipe are in compression.

A pencil pokes through this corroded metal! Why chance trouble like this? Cathodic Protection and ANACONDA Type CP Cable effectively check corrosion of buried metals.

For longer cable life in cathodic protection —Anaconda Type CP Cable

Moisture, soil acids and alkalies, and —most important — oil are tough on present cables used in Cathodic Protection.

Anaconda's new Type CP Cable is specially designed—with double covering of polyethylene and Densheath* (PVC) — to resist these enemies of cable life. This means less frequent replacement . . . major savings in both labor and material costs.

*Reg. U. S. Pat. Off.

Polyethylene and Densheath used in ANACONDA CP Cable are inherently resistant to oil. And they have high resistance to electro-endosmosis, as well as to moisture and most acids, alkalies and chemicals found in corrosive soil areas. Rugged Densheath jacket withstands toughest abrasion, and weathering.

This cable is light . . . easy to install, splice and terminate. Ask the Man from Anaconda—or your Distributor — for full information. Also — write for Bulletin DM 5450: "Anaconda Cathodic Protection Cable." Anaconda Wire & Cable Company, 25 Broadway, New York 4, New York.

55341

ANACONDA®
COPPER AND ALUMINUM WIRE AND CABLE

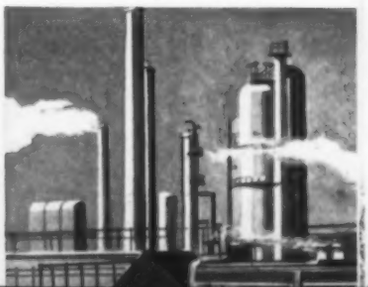
Where Anaconda Type CP Cable and Cathodic Protection Cut Corrosion Costs

Tank farms

Booster stations

Pipe lines

Oil Refineries



Placement of the final pipe was made recently on the 844-mile Southern Pacific Pipe Lines route from Los Angeles to El Paso at the 840-foot suspension span crossing the Colorado River at Yuma.

SP Products Line Begins Operation

The first shipment of petroleum products, gasoline from Standard Oil Company's refinery near El Paso consigned to Phoenix, Ariz., moved through Southern Pacific's pipe line which went into operation in January. The 844-mile line operates in two sections—the eastern leg from El Paso to Phoenix, and the Los Angeles to Phoenix branch, which is expected to be in operation soon.

Initially ten commercial shippers and the U. S. Air Force will use the line, which handles regular, premium and aviation gasoline, diesel oil and jet fuel. (See PIPE LINE INDUSTRY, July, August, October 1955.)

The SP line is the first common carrier pipe line owned and operated by a railroad subsidiary, Southern Pacific Pipe Lines, Inc., and is the first such common carrier line to receive products directly from military storage facilities.

The main line extends westward from the refineries at El Paso and eastward from the Los Angeles area refineries to the consuming areas around Phoenix and Tucson and certain intermediate points including Colton and Niland, Calif. Branch lines will total 176 miles of 6-inch pipe to serve four U. S. Air Force bases—March AFB near Riverside, Calif.; Davis-Monthan AFB near Tucson; Luke AFB northwest of Phoenix; and Williams AFB, southeast of Phoenix.

Contracts have been let to Engineers Limited Pipe Line Company and Hood Construction Company for three of the four schedules of the military pipe line work. The military system, a complete pipe line in itself with its own pumping stations and terminals, will be completed in March 1956.

Jet fuel and aviation gasoline will be received into the line at Norwalk, Calif., where J. H. Pomeroy & Co., Inc. has the construction contract. Work on the military pumping station at Colton, Calif., and the metering installation at March AFB is contracted to J. A. McNeil Company, Inc. The metering installations at Luke, Williams and Davis-Monthan Air Force Bases are contracted to M. M. Sundt Construction Company. The pump station project at Phoenix presently is out for bid.

By means of suspension spans, the main line crosses six major streams—the Rio Grande, San Pedro and Colorado Rivers and the Yuma Main, All American and Coachella canals.

Initial capacity of the line is 52,600 barrels per day which may be increased to an ultimate capacity of 76,100 barrels per day as pumping stations are added. Total cost of the project will be $35 million.

177-Mile Gas Line Planned By Shell in Venezuela

Cia Shell de Venezuela has announced plans for a 20-inch gas line, costing about $20 million, to move casinghead gas from La Paz field in the Maracaibo district to the Cardon refinery on Paraguana peninsula, 177 miles away.

Pipe is being delivered early in 1956 and the line is expected to be completed in 1957. The projected daily capacity is 106 million cubic feet. Gas will be the primary fuel for the refinery.

Do You Know

What Topaz Can Do For You?

Topaz is a sales and service organization offering you complete lines of nationally recognized pipeline supplies and equipment plus the consulting and supervisory services of experienced engineers. You can call Topaz night or day, with assurance that your needs will receive prompt personal attention.

Hot Tapping

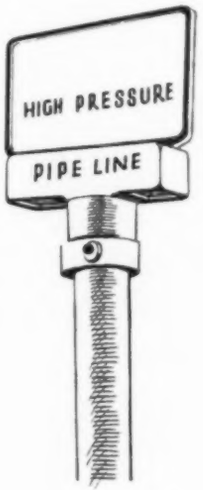
Topaz* sales engineers plan and supervise** hot tapping operations on gas, steam, water, products and chemical lines without costly shutdown. Hot tapping equipment may be contracted, leased or purchased. Topaz service includes consultation, supervision and instruction of company field personnel on use of purchased equipment.

Agent for T. D. Williamson, Inc.

***In Cooperation with T. D. Williamson, Inc.*

L & M Marker-Vents

L & M Marker-vents on highway and railroad casing vent pipes have proved both effective and economical. Less expensive than a field-welded vent hood, the aluminum alloy L & M Marker-vent will last the life of the line. Custom designed sign panels with your company name and emblem are available in your choice of colors. Sizes available for 2", 3" and 4" pipe. L & M products, distributed by Topaz* also include standard safety signs, well markers and aerial view markers.



Sole distributor for L & M products.

Consulting, Engineering and Supervision

Working in cooperation with engineering departments, Topaz sales engineers perform flow condition analyses, pigging, stopple application, inspection and line testing. All equipment for these operations may be leased, contracted or purchased through Topaz.

Cathodic Protection

All cathodic protection equipment and supplies, including rectifiers, anodes, coke breeze, pipe wrap and pipe coatings are available from one supplier . . . Topaz*. This means savings to you in time and paper work.

Agent for The Holcombe Co., Inc.

Other supplies available from Topaz:

- valves
- pipe cutting machines
- cutting and beveling machines
- odorizers
- clamps, hooks and dollies
- pipe saddles and reducers
- heavy machines
- torches

- Plus all other equipment or supplies necessary to complete your project.

Tod Pazdral *Pipeline Specialties*

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RICHARD LEE MCHENRY
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Alberta Trunk Line Gets Permit for Route Change

The Alberta Gas Trunk Line Company Ltd. has received permission to build a 547-mile system to transport gas from the Alberta fields to the western terminus of the Trans-Canada Pipe Lines Ltd. system. The company's application to the Alberta Petroleum and Natural Gas Conservation Board in January changed the original planned route, resulting in a reduction of the total mileage involved.

Major changes take the system cross-country from the Pincher Creek junction near Denhart to the Homeglen-Rimbey field. The former system moved westward from Denhart, then north to Calgary and due north to the Homeglen-Rimbey field. The new route also will be built in a more direct line to the Pincher Creek field.

Estimated to cost $47 million, the line will consist of from 6 to 34-inch pipe with about 219 miles to be laid the first year, and the remainder to be completed later.

Got a Hard-to-Handle Job?

Trust it to a BRADEN Winch

Where sureness and safety is extra important in handling heavy equipment, trust the job to a BRADEN Winch. Every BRADEN Winch is easy to control, and its PATENTED, OIL COOLED, FULLY ADJUSTABLE AUTOMATIC SAFETY BRAKE can be depended upon to hold the load during moving operations.

Your Best Winch Buy is BRADEN

See Your Braden Dealer or Write for Complete Information

BRADEN WINCH COMPANY
P. O. Box 547, Broken Arrow, Oklahoma

BRADEN Winches

"IN SERVICE AROUND THE WORLD"

Construction Begins On Canadian Gas Line

Construction along the route of Westcoast Transmission Company Limited natural gas line got underway recently.

Crews from the Fraser Valley, the central interior and Dawson Creek began moving to their locations while machinery was being assembled at strategic points.

First operations include clearing of the 60-foot wide right-of-way. No merchantable timber will be burned or otherwise destroyed. Registered firms of timber cruisers have been employed to evaluate timber on the right-of-way and disposition of the wood is made according to arrangements with the owners.

The 650-mile Westcoast main line starts in the Alberta, B. C. natural gas fields, and runs in a southerly direction to Huntingdon on the international border in the Fraser Valley, a few miles south of Abbotsford.

Canadian Bechtel Limited is project manager. Construction is being speeded to meet, or better the construction schedule calling for completion of the line in the fall of 1957. The 30-inch diameter welded steel line will cost $152 million, and its ultimate capacity will be 660 million cubic feet of gas per day.

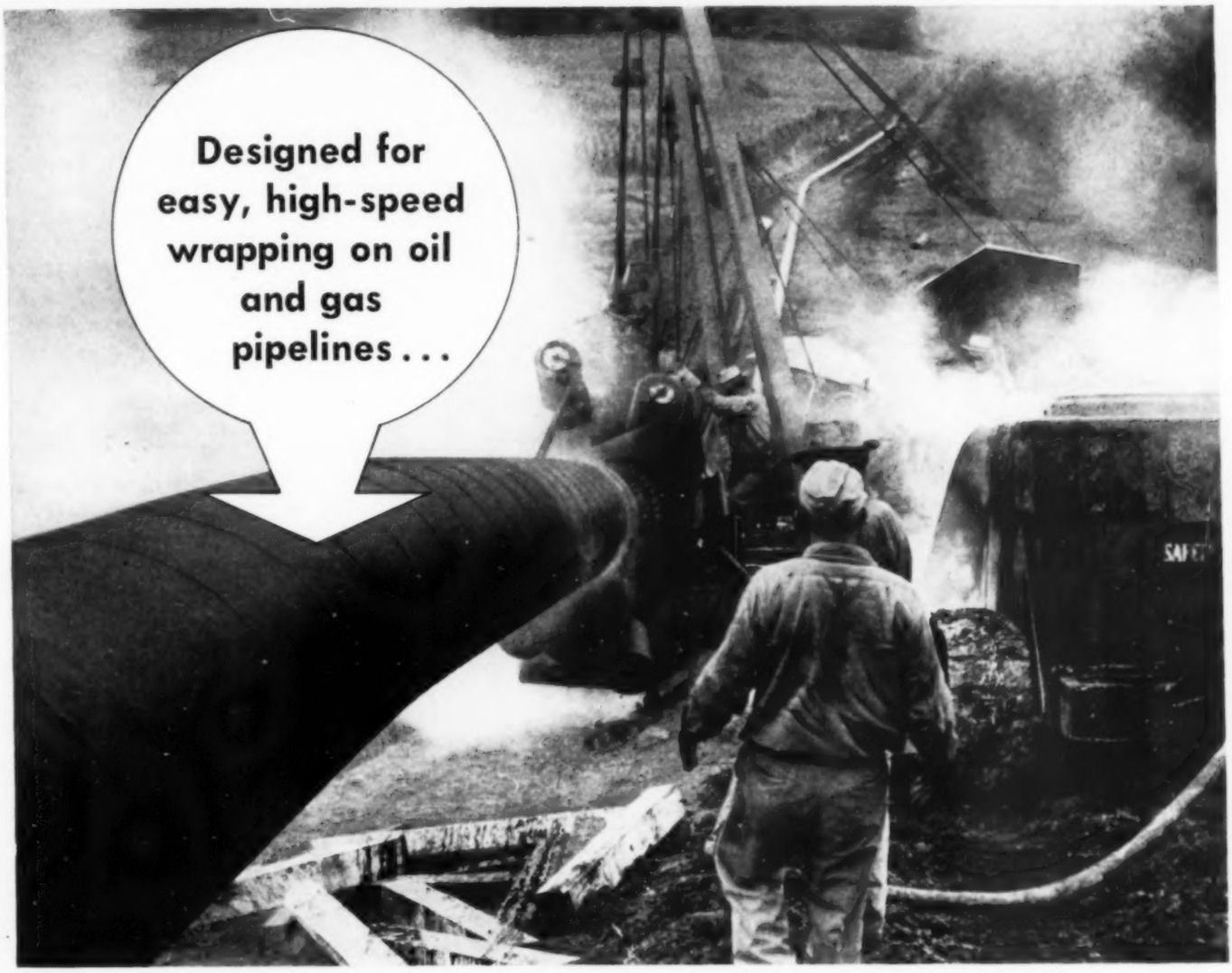
Dutton-Williams Brothers Limited, with headquarters in Dawson Creek, has commenced clearing on the first section at the northern end of the line.

Bechtel's Pipeline Construction division has opened headquarters at Quesnel for operations on the second section. Bechtel has a sub-contractor, Soverign Construction and Engineering Limited, clearing right-of-way in the Quesnel district.

Conyes Construction Corporation has a project office in Kamloops. A crew is unloading equipment, and a gang is clearing near Merritt in the third section.

Mannix Limited in the Fraser Valley section has headquarters in Chilliwack. This company completed several miles of pipe line in that area last fall, and is now clearing and preparing for river crossings in the Hope area.

About 200 men are working on the project at present. The force will be increased as weather permits.



Johns-Manville TRANSHIELD® ASBESTOS PIPE LINE FELT

goes on fast, restricts soil stress, cuts maintenance

ON job after job, pipe line men have found that Transhield Asbestos Pipe Line Felt meets the need for an economical asbestos shield that is effective in average soil conditions.

Contractors like Transhield because its special reinforcement makes it ideal for easy, high-speed application by modern machine methods. Consisting of a lightweight coal-tar-saturated asbestos felt, it is reinforced with continuous glass yarns parallel-spaced on ¼" centers. Transhield's light weight permits the use of 800-ft. rolls which increases application speeds since fewer stops for roll changes are required.

Transhield provides a continuous membrane between the pipe line enamel and the soil. It works effectively in preserving a continuous protective film of enamel on the pipe. During construction, it guards the enamel. After installation, it reduces the cold flow of the enamel, and acts as a surface barrier to restrict soil stress.

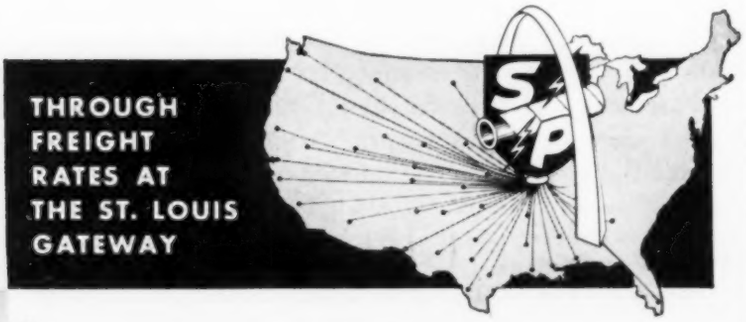
For further information write to Johns-Manville, Box 60, New York 16, N. Y.; in Canada, 565 Lakeshore Road East, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS **Johns-Manville** PRODUCTS FOR PIPE LINE PROTECTION

For more data on advertised products, use Readers' Service Cards, last page.

In 1955, C/W pipe sales again increased over the previous year. This is the sixth straight year that SPI's sales have shown a substantial increase.

Here again is proof of the industry's acceptance of the fact that SPI has all the machines, methods, and procedures necessary to produce the finest coated and wrapped pipe, and that SPI personnel has constantly made certain that your pipe has been delivered in time to meet your schedules.



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standard pipeprotection inc.
3000 SOUTH BRENTWOOD BLVD. • ST. LOUIS 17, MISSOURI

North Carolina Natural Gas To Build 575-Mile Line

North Carolina Natural Gas Corporation has received permission from the North Carolina Utilities Commission for the construction and operation of approximately 575 miles of natural gas pipe line within the state.

The North Carolina distribution system will have an initial capacity of 52 million cubic feet a day and will take its supply from Transcontinental Gas Pipe Line Corporation at a point near Mooresville, N. C. Ranging from 3 to 16-inch pipe, the line will cost about $13 million. Construction will begin early in the spring and is scheduled for completion in late summer. The line will deliver gas to customers in a territory east of Charlotte and south of Lexington, Sanford and Raleigh.

Minnesota Firm Proposes Natural Gas Pipe Line

Iron Ranges Natural Gas Company has applied to the Federal Power Commission for permission to construct natural gas pipe line facilities in Minnesota. The company proposes to build a 68-mile transmission system with 47 miles of supply laterals to various towns and cities on the Mesabi Iron Range in Minnesota at the cost of $2.8 million.

Daily transmission capacity of the proposed system would be 55 million cubic feet of gas a day which Iron Ranges plans to obtain from Midwestern Gas Transmission Company of Houston. The latter has an application pending for construction of a 1760-mile line from Tennessee to the U. S.-Canadian border.

River Construction to Lay 150-Mile Line for Sinclair

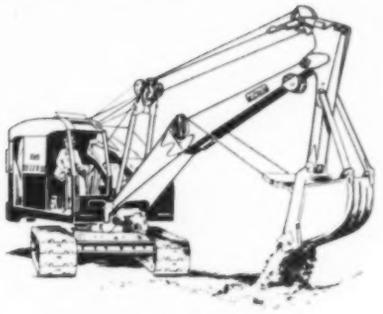
Sinclair Pipe Line Company, has announced the awarding of a contract for construction of a segment of the company's new "Big Inch" crude oil carrier in Texas.

The River Construction Corporation of Fort Worth will lay 150 miles of 18-inch pipe from Jacksboro to Teague, Texas. Construction will start about February 1, 1956, and is expected to be completed by May 1, 1956.

This line will provide necessary increased capacity to move north Texas oil to Teague, and from there to the Houston refinery area.

Here's Why
Bucyrus-Erie Dragshovels Save Trenching Time and Costs

YOU'RE OFF TO THE RIGHT START with a digging stroke that is powerful and steady so the operator can heap the dipper high. Power is concentrated at the dipper teeth for best penetration of even toughest material.



FOLLOW THROUGH, with really high-speed hoist and swing, gets dipper out of the trench and into dumping position with no waste of time or operator effort. Hoist and swing action are so smooth that spillage is kept at a minimum.

FINISHING THE CYCLE, the dump is clean and trigger-fast. The dipper's high arch, smooth sides and rounded heel are designed for quick easy dumping.

163E55

When you combine this kind of digging efficiency with the dependability that keeps maintenance costs way down, you have the machine you need for fast trenching in tough materials. See your Bucyrus-Erie distributor soon for complete details.

BUCYRUS ERIE

South Milwaukee Wisconsin

75 YEARS OF SERVICE to Men Who Shape the Earth

A ¾-yd. Model 22-B dragshovel, equipped with tractor-type treads, digs ditch for 24-in. natural gas pipeline in northern Pennsylvania.

For more data on advertised products, use Readers' Service Cards, last page.

Pacific Gas & Electric Plans Increase in System

Pacific Gas and Electric Company has requested approval from the California Public Utilities Commission of a $20 million project to increase by 25 percent the daily volume of gas the company imports from out-of-state fields.

Currently the company receives 700 million cubic feet daily from fields in Texas and New Mexico. The petition requests an increase to 875 million cubic feet daily in a four stage development starting in late 1956 and ending by 1959.

The plan calls for building 149.6 miles of 34-inch in parallel sections to the company's super inch transmission line from Topock, Ariz., north to Milpitas. Additional compressor capacity would be added to the three stations at Topock, Hinkley and Kettleman.

Arapahoe Pipe Line To Expand Facilities

The Arapahoe Pipe Line Company has announced plans for expanding its facilities. The expansion program includes the acquisition of 420 miles of existing pipe line.

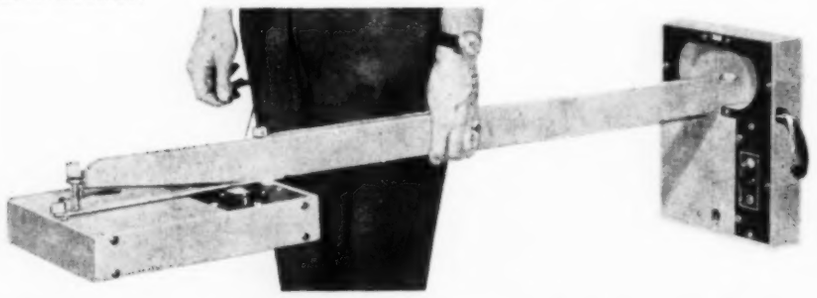
The plans call for the acquisition by Arapahoe from Pawnee Pipe Line Company of 33 miles of existing crude oil pipe line, 10 inches in diameter, running from the Adena field in Morgan County, Colo., to Merino, Colo., with gathering lines in the Adena area; 42 miles of 8-inch from Little Beaver field in Washington County, Colo., to Merino, including a gathering system. Seller of this line is Goodall Pipe Line Company. Arapahoe also will acquire 345 miles of oil field gathering lines in Kansas and Nebraska which feed into the Arapahoe system.

Arapahoe's principal trunk line extends from oil fields in northeastern Colorado and Nebraska to Humboldt, Kansas, where crude oil is delivered to connecting pipe lines.

The WILKINSON LINE LOCATOR

SEES WHERE YOU CAN'T

It will instantly locate all subsurface pipes, cables and such, and determine their depth too. The etched circuitry, our latest innovation, assures better quality control and performance than the customary hand wiring method. You can avoid damaged structures and loss of time with the Wilkinson Line Locator.

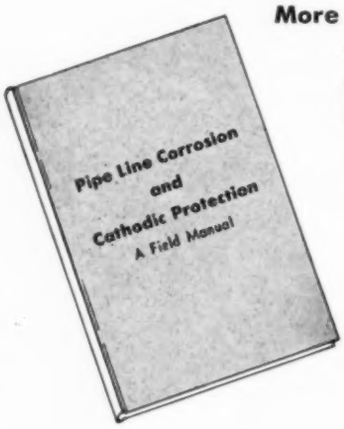


WILKINSON PRODUCTS COMPANY

3987 Chevy Chase Drive, Pasadena 3, California. SYlvan 0-4314

More comments on this new Handbook:

"... a most practical on-the-job manual for men concerned with pipe line corrosion. We are ordering copies for each of our district engineers."



Pipe Line Corrosion and Cathodic Protection

By MARSHALL E. PARKER

This Handbook, written by Marshall E. Parker, consultant, is designed as a practical field manual. It is a 108-page pocket-size volume printed first as a popular series in WORLD OIL. The Handbook is illustrated with many charts and drawings and is completely indexed by subjects.

It presents comprehensive data on Soil Resistivity Surveys, Potential Surveys, Line Currents, Current Requirements, Rectifier Systems, Ground Bed Design, Magnesium Anodes, Stray Current Electrolysis, Interference in Protective Systems, Operations and Maintenance, and Coating Protection and Testing.

An appendix has been added of technical data on Underground Corrosion, Basic Principles of Cathodic Protection, Properties of Metals and Attenuation Equations. Order copies of this practical Field Manual now for each of your field men. Price $3.

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The complete editorial index covering all issues of PIPE LINE INDUSTRY published during 1955 has been prepared and is bound separately in convenient pamphlet form. It will be sent free to all subscribers who write requesting copies.

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Here the HD-21 brings the line up to highway crossing.
Complete tractor spread includes two new Allis-Chalmers HD-21's
and 13 other Allis-Chalmers crawlers

Pipelining between the highlines

Allis-Chalmers Tractors lay 30-in. line on high tension right-of-way for Contracting and Material Company

Putting down a 30-in. gas line in trench only a few feet from high tension line towers is tough and tricky — but Contracting and Material Company, Evanston, Illinois, made it look easy with their Allis-Chalmers torque converter crawler tractors. The job, located in the outskirts of Joliet, Illinois, called for precision maneuvering, and the 39-ton Allis-Chalmers tractor-boom combinations moved around those steel towers with the ease and agility of a lightweight.

Torque converter tractors work as coordinated unit

In putting in this line, which was lowered directly from dope-wrap into the trench, three Allis-Chalmers torque converter crawler tractors, headed by the new HD-21, handled the job. The work involved frequent catch-off and catch-on by the tractors due to the closely spaced highline towers blocking the way. In spite of these obstacles, the three crawlers worked as a smoothly coordinated unit. With proved torque converter drive, they matched speed perfectly with the dope-wrap machine. The self-energizing brakes and easy-handling controls really paid off in the close-quarter maneuvering.

ALLIS-CHALMERS HD-21

204 net engine hp
127,000-lb lifting capacity at 4-ft overhang
78,250-lb tractor and side boom with full counterweight

Whether in close-quarter work or clear sailing on open right-of-way, you can cut costs and speed up operations with an Allis-Chalmers spread. Get full details on the completely new line of crawler tractors and matched equipment. Let your Allis-Chalmers dealer show you the all-new HD-21, HD-16, HD-11 and HD-6. See him now.

CONSTRUCTION MACHINERY DIVISION, MILWAUKEE 1, WISCONSIN

ALLIS-CHALMERS

Around the line she goes. Here the HD-21 catches-off the line and swings around the tower. Shifting is practically eliminated, operator can concentrate on his side-boom work and keep a lookout for the towers.

Proposed Pipe Line Construction

COMPANY	Length in Miles	Diameter	Type	Origin and Terminus	Estimated Cost	Status
Alabama-Tennessee Natural Gas Co.—Florence, Ala.	21	8, 12	Gas	Colbert County, Ala. loop.	$808,450	Authorized
Alberta Gas Trunk Line, Ltd.	547	6-34	Gas	From Alberta fields to western terminus of Trans Canada Pipe Line, Ltd.	$47 million	Approved
American Gilsonite Co.	80		Gilsonite Slurry	Bonanza, Utah—Western Colorado, refinery	.....	Considered
American Pipe Line Corp.—New York City (Swinerton & Walberg, Engineering)	1,425 plus 485 miles feeders & distribution lines	24, 26	Products	Beaumont, Texas area—Newark, N.J.	$170 million	Approved ODM
Arkansas-Louisiana Gas Co.	66	24	Gas	Arkansas, Louisiana and Texas loops	$9,245,166	Authorized
Big Horn Pipe Line Co.—Cheyenne, Wyo.	150	8	Crude	Ash Creek, Wyo. field—Midwest, Wyo.	.....	Considered
California-Oregon Pipe Line System	103	6	Crude	Crescent City, Calif.—Medford, Ore.	$2 million	Planned
Central Kentucky Natural Gas Co.	24	20, 24	Gas	Cold Springs—Anderson Ferry, Ky.	$2.5 million	Authorized
Chaco Pipeline & Refinery Corp.	450	....	Products	From Glenn McCarthy's Bolivian wells to new refinery at Conception, Paraguay	.....	Before FPC
Cities Service Gas Co.—1st National Bank Bldg., Oklahoma City, Okla.	15.5	16	Gas	Various locations in Kansas and Oklahoma	.....	Planned
Coastal Transmission Corp.—Houston, Texas	500	30	Gas	McAllen, Texas—Louisiana connection, Houston, Texas Gas.	$70 million	Considered
Colorado Interstate Gas Co.	115	4, 6, 8	Gas	Denver—Julesburg Basin—Basin Cities	.....	Before FPC
	328	16, 18	Gas	LaPlata County—Pueblo, Colorado Springs and Denver	$21,600,000	Authorized
Compania Shell de Venezuela	177	20	Gas	La Paz field to Cardon refinery on Paraguana peninsula	$20 million	Planned
Consolidated Gathering Systems, Ltd.	198	....	Crude	Sturgeon Field—Edmonton.	.....	Planned
Consolidated Natural Gas Corp.—New York	112	....	Gas	In Ohio—Plus other smaller lines	$6 million	Planned
Cosden Petroleum Corp.—Big Spring, Texas	100	6	Products	Big Spring—Abilene, Texas	$1.5 million	Planned
Deep Rock Gas Co.	120	6	LPG	Tioga, N.D.—Canadian border	.....	Planned
El Paso Natural Gas Co.—El Paso, Tex.	414	34	Gas	Parallel from San Juan Basin to Topock, Ariz.	$194 million	Authorized
Freedom-Valvoline Oil Co.	34	8	Products	Harpster—Findlay, Ohio	$700,500	Planned
Houston Texas Gas & Oil Co.—4604 Main St., Houston	961	12-30	Gas	Baton Rouge, La.—Miami, Fla.	$110 million	Before FPC
Iraq Petroleum Co.	75	24	Crude	Homs, Syria to Tripoli, Lebanon	.....	Considered
Iron Ranges Natural Gas Co.	115	....	Gas	From Itasca and St. Louis Counties along route of Mesabi range from Grand Rapids to Aurora, Minn.	$5 million	Before FPC
Lone Star Gas Co.—Dallas	230	22, 26	Gas	Cotton County, Okla.—Fritch, Texas	$18.7 million	Before FPC
	205	....	Gas	Snyder, Texas to tie in with Cotton County, Okla.—Fritch, Texas line	.....	Before FPC
Magna Pipeline Company	40	....	Gas	Underwater line from Anacortes, Wash. to Victoria	$6 million	Planned
Malco Pipe Line, Inc.	91	6	Products	Prewitt, N.M.—Albuquerque	$1,250,000	Considered
Manufacturers, Gas, Light, and Heat Co.	72	16-20	Gas	Doddridge, Wetzel, and Marshall Counties, W. Va.	.....	Planned
	213	3-26	Gas	Various locations in Pa., W. Va., and Ohio	.....	Planned
	40	....	Gas	Allegheny, Washington, and Beaver Counties, Pa.	.....	Planned
Michigan-Wisconsin Pipe Line Co.—500 Griswold, Detroit	252	4-24	Gas	Various locations in Illinois and Wisconsin	$11 million	Planned
Midwestern Gas Transmission Co., Houston, Texas	1112	....	Gas	Emerson, Manitoba—Nashville, Tenn.	$98 million	Before FPC
Montana-Dakota Utilities Co.—Minneapolis	44	....	Gas	Various locations in S.D. and Wyoming	$1.4 million	Authorized
	41.8	12	Gas	Williams County, N.D.	$1.4 million	Authorized
NATO	1920	4-10	Products	To serve military bases in Western Europe	.....	Foster-Wheeler Prime Contractors, 875 miles let
Natural Gas Pipe Line Co. of America—20 N. Wacker Dr., Chicago	350	20, 26	Gas	Wise County, Texas—Fritch, Texas	$28.5 million	Before FPC
Nevada Natural Gas Co.	114	12, 16	Gas	Various loops along Needles, Calif.-Las Vegas, Nev. line	$2.5 million	Planned
New York State Natural Gas Corp.	56.5	30	Gas	Tioga County, Pa.	$7 million	Before FPC, 12 miles Authorized
North Carolina Natural Gas Corp.	575	3-16	Gas	Mooresville eastwardly across North Carolina	$13 million	Authorized
Northern Natural Gas Co.—2223 Dodge St., Omaha	167	24	Gas	Farmington, Minn. to Duluth, Minn. and Superior, Wis.	$12 million	Before FPC
	....	....	Gas	To interconnect with Natural Gas Pipe Line	$244,000	Planned
	28.4	30	Gas	Test lines to underground storage near Redfield, Iowa	$4.8 million	Before FPC
	15	24	Gas	To main line in Nebraska	.....	Before FPC
	163	10, 12	Gas	Various locations in South Dakota, plus 307 miles of branch lines	.....	Before FPC
	6	6	Gas	Iowa loop and compressor additions in Texas	$760,000	Before FPC
Northwestern Utilities, Ltd.—10124-104th St., Edmonton, Alberta, Canada	42	12	Gas	Bonnie Glen—Edmonton, Alberta	$1.4 million	Planned
Offshore Gathering Corp., Houston	364	24, 26, 30	Gas, Crude	Texas side of Saline River 25 miles offshore La. to Mississippi side of Pearl River	$150 million	Before FPC
Pacific Gas & Electric Co.	150	34	Gas	Various loops, between Topock, Ariz.—Milpitas, Calif.	$4 million	Planned
Pacific Northwest Pipe Line Corp.—M & M Bldg., Houston	1770 plus 443	22, 26	Gas	San Juan Basin—Pacific Northwestern states and Canadian border terminus near Sumas, Wash.	$246 million	Contracts let for 1221 miles
Petroargentina	370	16	Crude	Newguen—Bahia Blanca, Argentina	$40 million	Planned
Petroleos Mexicanos—Ave. Juarez, 94, Mexico City	440	20	Gas	Brazil—Tampico—Poza Rica, Mexico	.....	Planned
	260	6, 8	Products	Lagos, Mexico—Guadalajara, Aguascalientes and Salamanca	.....	Planned
	145	12	Crude	18 de Marzo Field—Monterrey, Mexico	.....	Considered
	....	....	Gas	Macuspana region of Tabasco to Veracruz port of Minatitlan	$6 million	Planned
Phillips Petroleum Co.—Bartlesville	54	6	Products	Goldsmith—Borger, Texas	.....	Planned
	50	....	Ethylene	Sweeny—Pasadena, Texas	.....	Planned
	22	20	Gas	Roberts County, Texas, to Rock Creek gasoline plant	.....	Approved
Pioneer Natural Gas Co.	261	3-22	Gas	Various locations in Texas Panhandle	.....	Planned
Plantation Pipe Line Co.	327	18	Crude	Baton Rouge, La. to Helena, Ala.	$23.5 million	Planned
South Alberta Pipe Line, Ltd.	46	10	Gas	Etzikom Field—Medicine Hat, Alberta	$1 million	Planned
Southern Calif. Gas Co. and Southern Counties Gas Co.	278	30	Gas	Topock, Ariz.—Newhall	$31 million	Planned
Southern Natural Gas Company	39	....	Gas	Various locations in Ga. and La.	$2.2 million	Authorized
Standard Pipe Line Co.	330	16	Crude	Wink, Texas—Albuquerque, N.M.	.....	Before ODM
Stanmount Pipe Line Co.	140	10	Crude	Cayiga and Beaver Lake Fields, N.D. to connect with Interprovincial Pipe Line	.....	Planned
Sturgeon Pipe Line Ltd.	100	12	.....	Sturgeon Lake Field—Trans-Mountain system	$6,500,000	Planned
Sun Pipe Line Company	110	14	Products	Marcus Hook, Penn., to Newark, N.J.	.....	Planned
Sunflower Pipe Line Co.—Tulsa, Okla.	265	3-6	LPG	Kearny, Grant and Haskel Counties, Kansas—Wichita, Kansas	$3.5 million	Authorized
Tennessee Gas Transmission Co.—Box 2511, Houston (See also Midwestern Gas Transmission Co.)	220	26, 30	Gas	Loops in Kentucky and Ohio plus 376 miles of Supply	$56 million	Authorized
	100	....	Gas	Gathering lines in Texas and Louisiana plus station additions	$18.6 million	Before FPC
	1,050	....	Gas	Border near Emerson, Manitoba—Nashville, Tenn.	.....	Proposed
	162	....	Gas	Loop Lines in Kentucky, Ohio, and Pennsylvania	$24.3 million	Before FPC
Texas Eastern Transmission Corp.	422	30	Gas	McAllen to Vidor, Texas	Estimated	Planned
	530	30	Gas	Loops at various points between Kosciusko, Miss. and Uniontown, Penn.	Cost of Entire Project	Planned
	45	24	Gas	Provident City, Texas crossover to McAllen-Vidor line	$150	Planned
	135			Supply and delivery lines laterals	Million	Planned
Texas Eastern Transmission Corp. and Texas Eastern, Penn-Jersey Corp.	11	....	Gas	Loops in Philadelphia area plus compressor facilities	$2.4 million	Authorized
Texas Gas Transmission Corp	198	20	Gas	East Lake Palourde Gas field, La. to Eunice, La. and loops paralleling existing system in Arkansas, Mississippi, Tennessee, Kentucky, Indiana	$20 million	Authorized
	....	....	Gas	Houston, Texas—Miami, Fla.	.....	Considered
Trans-Canada Pipe Line, Ltd.—Calgary, Alberta	2240	30, 36	Gas	Alberta—Eastern Canada	$297 million	Planned
Transcontinental Gas Pipe Line Corp.—3100 Travis St., Houston	....	....	Gas	Connecting facilities with Texas Eastern Penn-Jersey in Pennsylvania and New Jersey	$131,628	Authorized
	24.2	....	Gas	Gathering Lines from South Bayou Mallet, Maxie and Happytown Fields, La.	$754,000	Authorized
United Gas Pipe Line Co.	63	16, 20	Gas	Various locations in Miss., Ala. and Florida	$8.3 million	Authorized
United Natural Gas Co.	50	12	Gas	Elk County—Jefferson County, Pa.	.....	Planned
U. S. Navy	450	8	Gas	Gubik Field—Fairbanks, Alaska	$20 million	Planned
Washington Gas Light Co.—Washington, D.C.	11	24	Gas	Chillum Station—Gordon's Corner, Md.	$2 million	Authorized
Westcoast Transmission Company, Ltd.	270	8-26	Gas	Various locations in Peace River region	.....	Planned
Wilcox Trend Gathering System, Inc.	16	16	Gas	Gathering lines to Provident City, Texas	$2.9 million	Before FPC
Winnipeg and Central Gas Co.	450	4-8	LPG	Tioga, N.D.—Winnipeg, Canada	$20 million	Planned

The recognized superlative performance of the Cleveland Model 320 Trencher was further improved during 1955 by the addition of the following features: increased width capacity (52 inches)—heavier rims and buckets (¾ inch hi-tensile steel)—crawler kick-out clutch—added conveyor-discharge length and height. Get the complete dope on these new features of the "320" and on other Cleveland Trenchers and Backfillers from your local distributor now.

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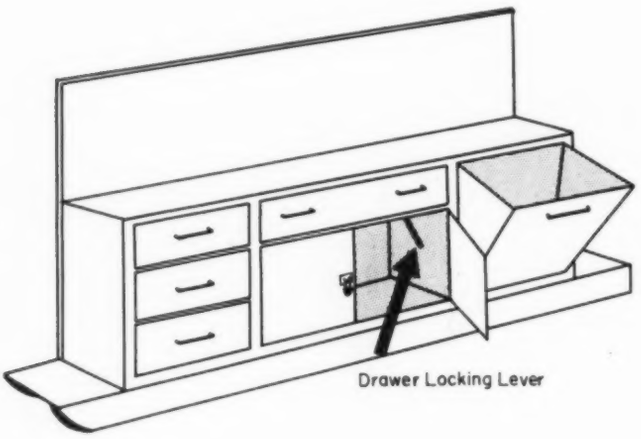
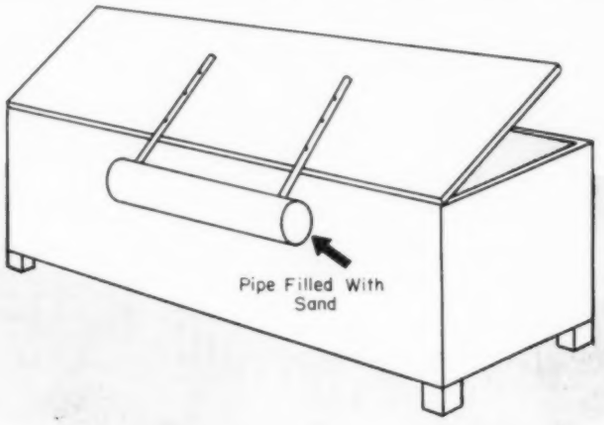




Station Tool Boxes Feature Opening and Locking Devices

Here are two ideas for station tool boxes, one that is easily moved and one that is stationary.

The tool box at left has drawers for small tools and parts, shelves for the larger ones and a swing-out compartment for wiping rags or other bulk material. All the drawers and the swing-out compartment can be locked by throwing a lever on the side of the doorway opening. This lever actuates a bar inside the unit which engages in holes in each of the drawers and compartments. The lever can be locked in place and the doors swung shut and locked from the outside with one key. Only one lock is needed for all eight compartments, thus saving time and money.

The top of the box provides a handy work area and has a vise mounted on one end. Hooks for hanging tools temporarily are located above the bench. On the other end is a telescoping stand for support of pipe in the vise and a hook to facilitate loading box.

Around stations where tool boxes are not moved frequently, a simple counter-weight can be used to facilitate lifting the lid of the box. After making the tool box, fill a short length of six-inch pipe with sand and weld it shut on both ends. Attach bars along the top of the tool box and weld the weighted pipe to the end of the bars so that it counterbalances slightly more than half the weight of the tool box door.

The counterbalanced lid makes access to tools and parts stored in the box much more convenient. Because of the ease of raising and lowering the lid, the crew is more likely to close the box after getting material.

Useful Welding Trailer Can Be Made from Scrap

This tandem trailer shown was fabricated from scrap parts found around a welding shop and from floor plate material. The trailer bed was made by taking the rear wheels and axles off an automobile and welding them to a bed with a tongue to fit the trailer hitch on a pickup truck.

Bins for tools and parts were made of floor plate over the wheels. These long compartments on each side have a full length lid to provide ready access. Compartments on the front have a large swinging door on each side for bulky tools and parts.

The welder's principal equipment is mounted in the center section; the electric welder mounted on the back and the bottles of oxygen and acetylene just ahead of the generator. With the units mounted well to the rear, there

is still plenty of room in front of them for loose tools and parts. A vise mounted on the left side at the front can be swung around so that the top of the box may be used for a work bench.

Night Sighting Aid Speeds Water Surveying

Use of a Navy type distress signal during night surveying operations saves a lot of time when surveying a right-of-way across long stretches of open water or on level terrain ashore.

Engineers prefer to run the straight line as far as possible so the point to be reached may be out of sight through a transit.

To set a transit on the point over the horizon, set it up at night in the approximate direction by magnetic bearing. Then at the point of termination, fire the flare straight up into the air. The flare can be sighted through the transit and the direction of the desired point establishd. Stakes can then be set on the line and the survey continued.

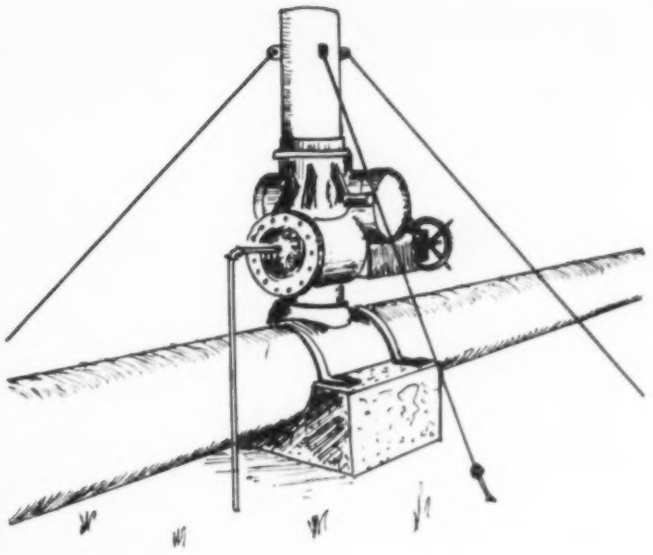
Ashore, an automobile spotlight or other lighting device may be used, instead.

Seat Belts in Cars, Trucks Are Good Safety Measure

One pipe line company already has commenced a program of installing seat belts in its company fleet of 346 trucks and 186 cars. First an extensive test program was carried out to determine the strength of the belts and how well they would stand up under various hazards.

Although not a new idea, the use of safety belts in vehicles is on the growth in pipe line work. One gas pipe line company engineer has had belts installed in his car for years.

Here is how belts can be installed. The belt passes between the seat and the back rest down through the floor where it is fastened to a pipe welded underneath the floor. Two or three belts per seat may be installed in this manner.

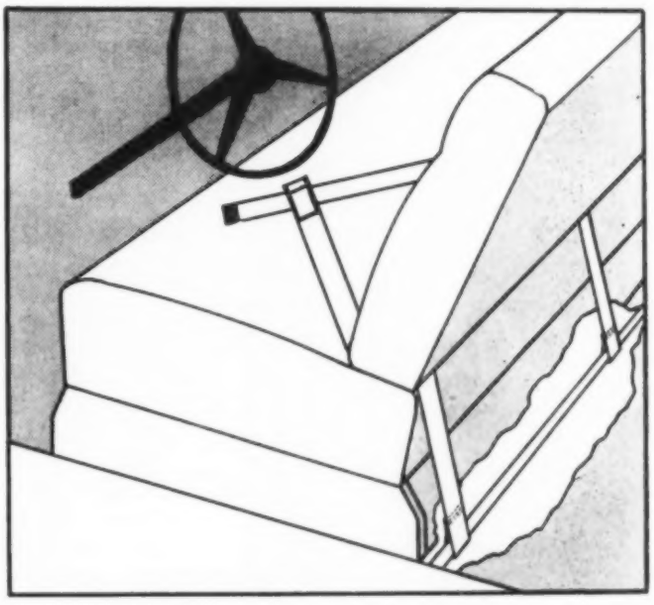


Design Base for Jet Action Of Blowdown Valves

The jet action of gas line blowdown valves can damage a piping system seriously if foundations are not properly designed. Here is an idea for a well-designed foundation, using precast concrete base and steel bracings.

Action of the blowdown system can be compared to a jet plane's engine. When the valve is opened, gas is released to atmosphere at the velocity of sound. The high-velocity jet action of the discharging gas results in a reaction in the blowdown system, causing it to move in a direction opposite to that of the gas.

The jet effect has been reported to be the equivalent of 16,000 horsepower, greater than the power of any jet plane. Therefore, it is necessary to install foundations that can withstand the reactive force. The jet effect is most severe at the beginning of the blowdown period. As line pressure decreases to zero, so does the jet effect. This foundation illustrated takes into account the maximum force exerted, rather than the average figure for the force during the entire blowdown period.



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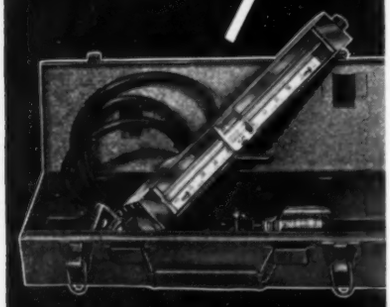

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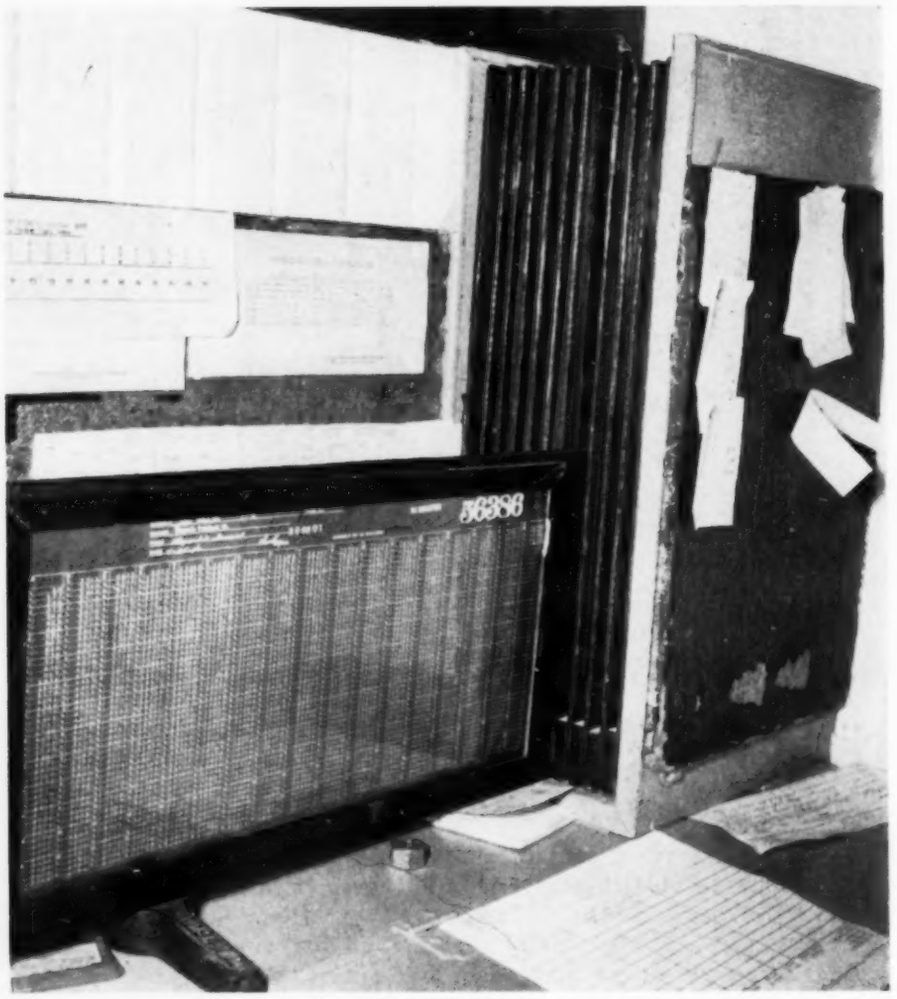


Make Handy Rack for Tank Tables

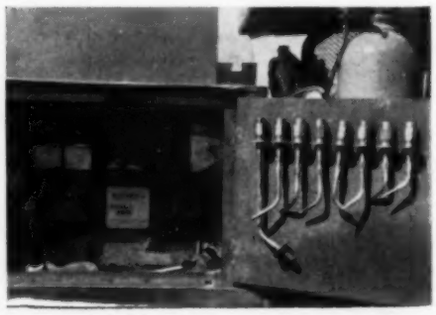
A pumper looking after more than one lease or a large lease with a number of tanks in the battery usually has quite a problem keeping all of the tank tables readable, but one pumper has developed a unique system for keeping tables neat, readable and readily available for daily figuring.

Each tank table is framed in the proper size frames, complete with a glass front. A rack of the proper size to contain all framed tank tables is mounted on the top right hand side of the pumper's "knowledge box." The frames are hinged in place by bolting through the lower right hand corner of the frames. When not in use, the tables fold up into the rack out of the way. When a table is needed, it is swung down on the bolt hinge and drops across the pumper's desk in a handy position for working with figures.

Hang Welding Tips On Compartment Door

On jobs where various sizes of welding tips are needed with various types of rods, a handy rack may be made on the inside of the door of the welding rod storage compartment on the truck.

Weld "ears" to the inside of the door with holes to accommodate the different welding tips. When the welder opens the door to get a welding rod for a certain purpose, he can switch the torches without having to fumble in a bin inside the door.

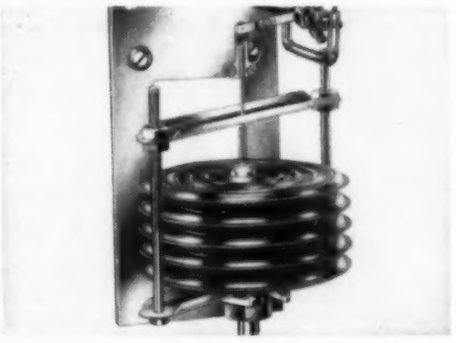


How much do you know about Recording Pressure Gauges?

1 **Q.** Why are more Bristol Recording Gauges used than all others combined?

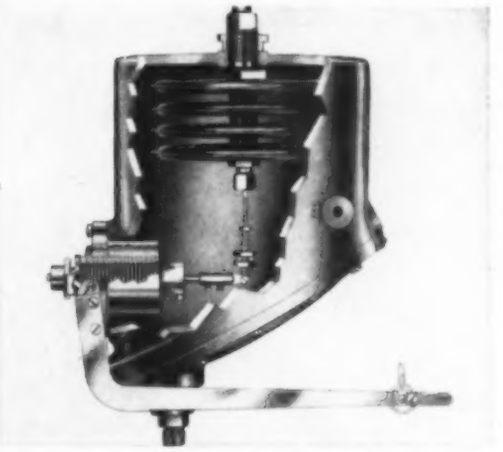
A. BRISTOL'S PRESSURE MEASURING ELEMENT, heart of the pressure gauge, is the big reason. Bristol Pressure Gauges, operating all over the world under all conditions – some in constant service for 20, 30, even 40 years – prove its accuracy, long life, and stability.

2 **Q.** What's the *right* measuring element for low pressure ranges?



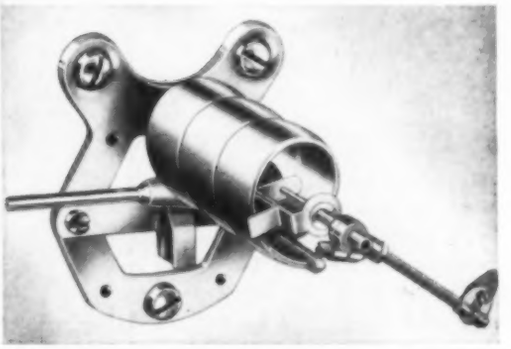
A. BRISTOL'S DIAPHRAGM MEASURING ELEMENT, for ranges from 0–2 in. water to 0–29.9 psi. Extremely high torque gives positive pen positioning across entire range. It's highly accurate, extremely stable. 250% inherent over-range protection.

3 **Q.** What's the *right* measuring element for absolute pressures?



A. BRISTOL'S SINGLE-BELLOWS TYPE ELEMENT. It measures ranges as low as 0–6mm mercury absolute and gives direct reading of pressure above absolute zero corrected for barometric variations – with far greater accuracy than ever before.

4 **Q.** For intermediate and high pressures?



A. CORRECT ANSWER here is either Bristol's *Type 316 stainless steel* or *non-ferrous alloy* helical measuring elements. They're designed for ranges from 0–30 psi all the way up to 0–10,000 psi. Withstand impact of rapid fluctuations, give *permanent* accuracy over a long period of service life.

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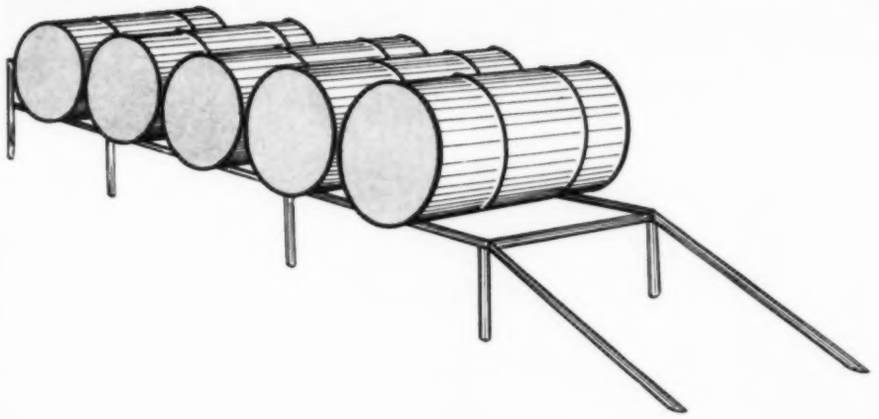


Pipe Ramp Makes Drum Storage Easier

By fabricating a simple pipe rack, station lube oil drum storage can be made easier and drums kept in good condition. Scrap pipe two or three inches in diameter is cut to length needed to give desired height and is set in concrete footings. To these legs two lengths of pipe are welded to make horizontal rack members as shown.

Two pipes welded to the end of each ramp form a labor-saving ramp up which the full drums can be rolled. Drums thus are kept clean and free from corrosion.

Assemble Battery Fittings To Save Repair Time

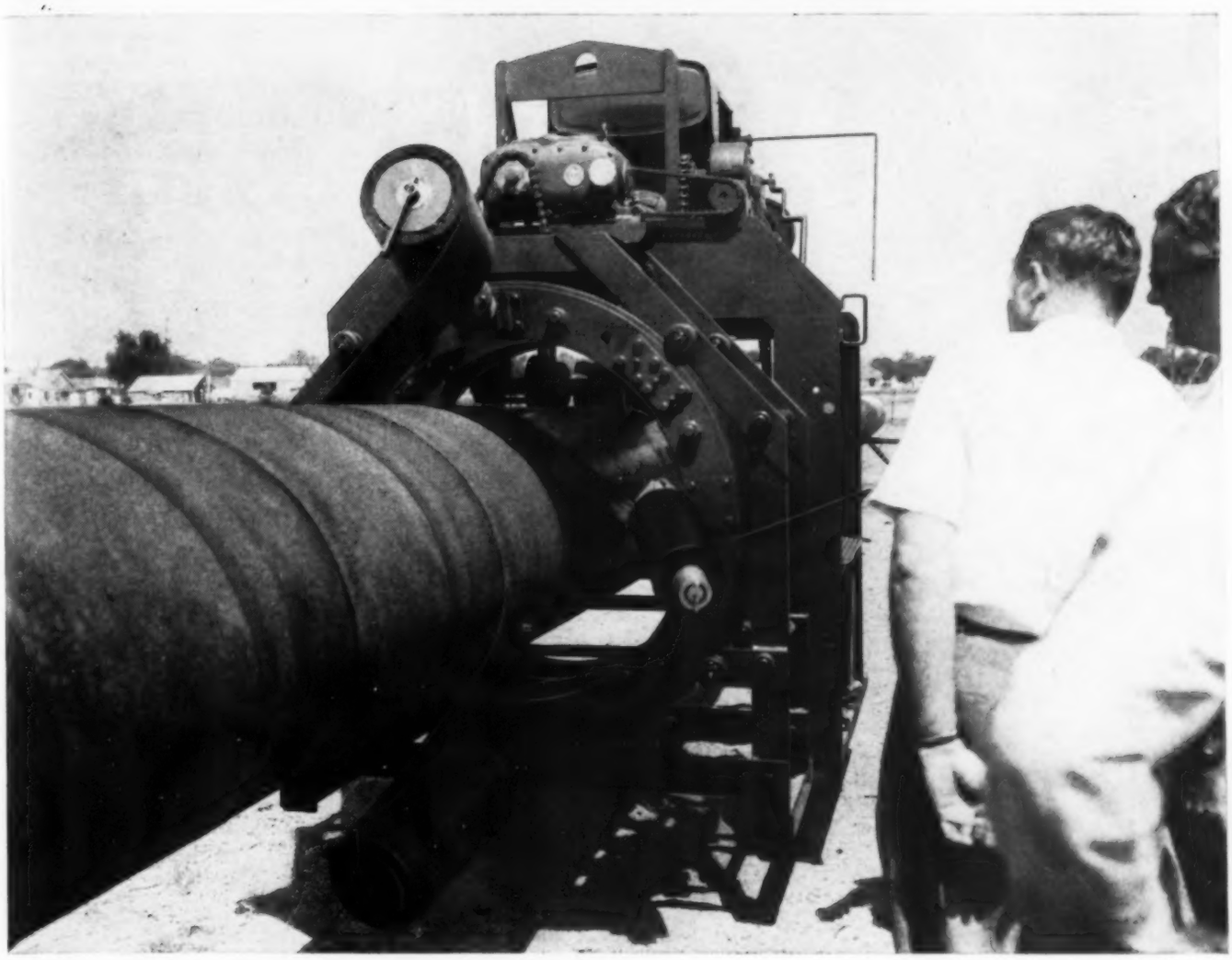
Making up a standard assembly for tank batteries can save much fitting time during repair of any unit. Here the sleeve union, block valve, swing check valve, and low gage shut-off valve are unitized above ground, while the line between the tanks is buried. Any fitting may be unbolted and reconnected quickly when repair is needed.

These fittings may be assembled ahead of time in a station shop and fitted to the line as a unit. The pipe line crew may leave the assembly a few inches off the ground to be connected into place later if desired. The sleeve union allows a few inches for make-up.

Use Existing Connections In Making Scraper Traps

Here is a simple means of making scraper traps using existing connections. Where a pipe line ended with a running tee and a valve on the side connection, one pipe line company put a dog leg into a nipple and fitted it to the end of the tee. A quick-acting union and bleed-off connection were installed on the nipple, so it would catch the pig without any more connections being necessary.

On the smaller line shown in the foreground, pigs are run only about once a year, so the line is simply bull-plugged on the end and drained to get the pig.



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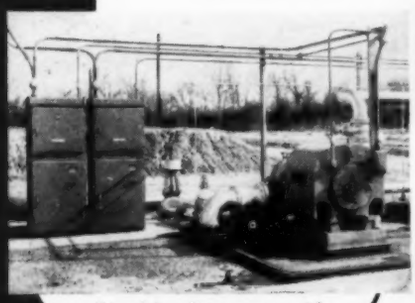

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The tank is mounted on a frame made of 3-inch pipe with one-inch stringers along the side to stiffen it. A loop is welded to the front of the frame for the hook on the winch line. A 2-inch frame is fabricated and welded up so that the top pieces pass through the front and back pieces of the 3-inch pipe as shown.

Plates can be welded to the sides of the legs and the frame so that a piece of 2-inch pipe which is slotted will fit over the plates. Matched holes are burned through the ends of the 2-inch braces and plates. Pins with chains attached are placed in the holes to keep the legs erect.

When it is time to move, the truck is backed up to the support, the pins removed and the load skidded over onto the truck with the winch line. The legs lay flat alongside the skids.

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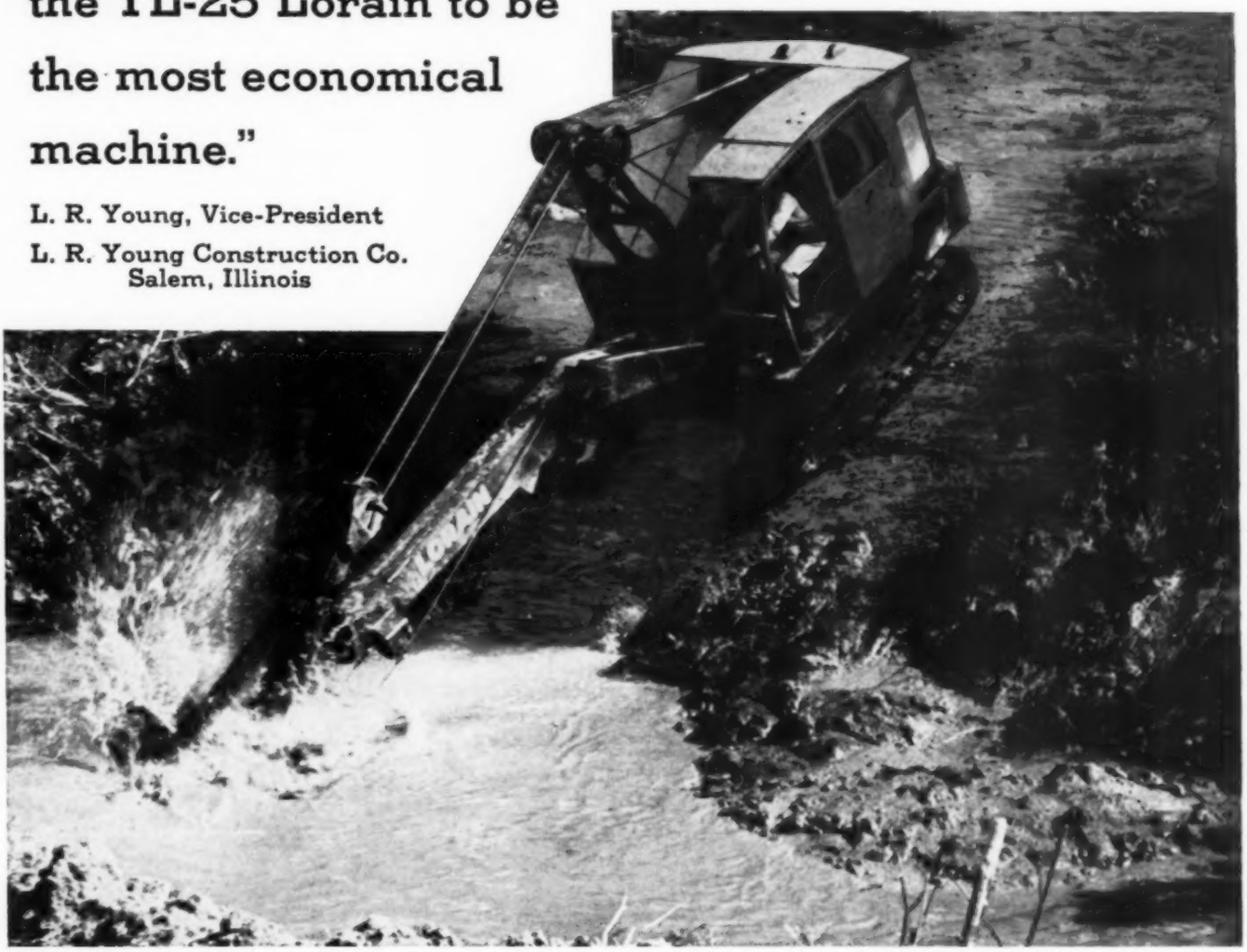
Salem, Illinois

These are the words of an experienced pipeline man. Lorain Hoes have gone with his spreads over many miles of the toughest terrain. Typical is the job below where a ¾-yd. Lorain-25 Hoe works on the bank of the Saline River in Illinois. This is part of a 16 mile long, 6" crude oil line, for the Sohio Pipeline Co., running from the Eldorado Pool to Enfield, Illinois. Below are some special reasons that pipeliners like Lorain performance—there are many more.



LORAIN features for pipelining needs

Here's more operating ease and quicker response in today's ¾-yd. Lorains. From the operator's cab—with turntable in any swing position—the operator simply flicks a lever and hydraulic power goes to work on all crawler controls.

- INDEPENDENT HOUSE LOCK is engaged promptly and positively and released instantly by hydraulic power through a handy, easy-acting control, to prevent turntable rotation.
- SWING AND TRAVEL JAW CLUTCHES are selected and engaged by simply flipping a control.
- TREAD LOCKING PAWLS are fully enclosed . . . protected from dirt and mud and are instantly engaged and released by fast-acting hydraulic power.
- CRAWLER STEERING is hydraulically power controlled by a single short lever—no operator fatigue. Steer either right or left while traveling forward or backward, with turntable in any position of swing.
- SEALED IDLER ROLLERS on anti-friction bearings keep out mud, water and abrasive materials.
- DROP-FORGED TREADS with REPLACEABLE TREAD PIN BUSHINGS reduce maintenance.
- GOOSENECK HOE BOOM up to 19 ft. long. All welded.

Check the many additional Lorain features with your Thew-Lorain Distributor before you plan your next job.

THE THEW SHOVEL CO., LORAIN, OHIO

THEW LORAIN®

For more data on advertised products, use Readers' Service Cards, last page.

Pipe Line Men

IN THE NEWS

New engineering organization, Williams Brothers Corporation, has been formed to handle the engineering work of Williams Brothers pipe line organization. Officers are, left to right, John Williams, president; Wilson N. Gilliat, chief engineer; Vincent E. Butler, vice president, and C. M. Collins, executive vice president.

John H. Williams, president of Williams Brothers, has announced the formation of the Williams Brothers Corporation, organized to handle the engineering work of various Williams enterprises.

Officials of the new corporation, all of whom are professional engineers, are John Williams, president; C. M. Collins, executive vice president; Vincent Butler, vice president; and Wilson N. Gilliat, chief engineer. All have been promoted from the Engineering department of Williams Brothers pipe line organization.

Collins steps up from the position of chief engineer of Williams Brothers Company. Butler was chief engineer for The Texas Company in Venezuela from 1947 until 1952 when he joined the Williams firm. Gilliat joined the organization in 1954 after serving with Burns and McDonnell, Engineers of Kansas City, C. F. Braun, and Great Lakes Pipe Line Company.

Stanolind Oil and Gas Company announced three personnel changes in the Louisiana Gulf Coast division. **F. L. Nelson,** former assistant division engineer, was made field superintendent of the company's Luby area near Corpus Christi, Texas and **M. Scott Kraemer,** formerly Houston district engineer, took Nelson's position. **Jack McWilliams,** former senior petroleum engineer, was promoted to Houston district engineer.

•

Homer R. Swift, superintendent of right of way, **Service Pipe Line Company,** has been elected president of Heart of America Chapter 5, American Right of Way Association in Kansas City. Swift assisted in organizing the chapter in Kansas City in 1953. There are 13 chapters in the U. S. with membership composed of agents, appraisers, attorneys and other persons engaged in right-of-way work for highways, utilities, railroads and the oil and gas industries.

•

H. O. Porter, assistant superintendent of transmission for **Cities Service Gas Company** since 1953, has been promoted to superintendent of transmission at Wichita. He fills the vacancy left by the death of **L. C. Benne.**

Hugh Owen, former assistant to the superintendent of Division II of **Texas Gas Transmission Corporation** Pipe Line department, has been named manager of the Owensboro Pipe Line district. Owen joined a predecessor company of Texas Gas in 1946 as an engineer and became assistant to **Felix Phillips,** division superintendent, in 1953. Owen replaces **Aaron Griffin** who has been appointed to a newly-created position of assistant superintendent in Pipe Line Divisison II.

•

Sun Pipe Line Company has announced the advancement of **J. B. Turner** to the position of chief engineer of the Crude Lines department with headquarters in Beaumont, Texas. The position formerly was held by **S. E. Ogle**, who has been relieved of the direction of the Engineering department so he can devote more time to administrative and management problems. Olge will continue as vice president and director of the company.

•

C. C. Combs has been elected vice president and treasurer of **Shell Pipe Line Corporation** succeeding **W. A. Baker,** who retired. Combs joined Shell in 1923 and moved through various positions to become assistant corporate secretary of Shell Oil Company in 1940 and added the duties of assistant treasurer in 1942. He became assistant treasurer and assistant controller in San Francisco in 1949. Since 1950 he has been on various special assignments, including three years as controller of Shell Oil Company of Canada.

C. C. Combs

Baker joined the Shell organization in 1921 as an accountant. He worked in San Francisco, Los Angeles, St. Louis and was transferred to Houston in 1940 as an assistant treasurer in Shell Oil Company. He was elected vice president and treasurer of Shell Pipe Line Corporation in 1946.

for better pipeline performance
get the best in pipeline protection

KONTOL 77®

CORROSION PREVENTIVE

Kontol 77 corrosion preventive protects pipe lines against internal corrosion, fouling and scaling. It also is very effective in the maintenance of a high "C" factor. Kontol 77 preventive is an organic, semi-polar liquid and is harmless to the quality specifications of finished products. Kontol 77 meets military specifications as an approved rust and corrosion inhibitor for use in jet fuels and automotive gasoline. Kontol 77 provides effective initial treatment at a ratio of one half gallon to a thousand barrels; after the initial treatment, continuing protection usually is obtained at a one quart per thousand barrel ratio.

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CHEMICALS AND SERVICES FOR THE PETROLEUM INDUSTRY

DEMULSIFYING, DESALTING, CORROSION PREVENTING, WATER DE-OILING, PARAFFIN REMOVAL, SCALE PREVENTING, PRODUCTION STIMULATING

XPL 565

Preston D. Phillips, Jr.

Frank O. Stivers

Humble Pipe Line Company has announced the promotion of **Preston D. Phillips, Jr.**, from chief engineer to assistant general superintendent and **Frank O. Stivers** from assistant chief engineer to chief engineer. Other supervisory personnel promotions include **Charles P. Endress,** from assistant division head to assistant treasurer; **James E. Oliver,** from chief clerk to assistant coordinator of personnel and policy; and **Clarence B. Lee,** from assistant superintendent to superintendent of the McCamey district.

TAR-HEATING KETTLES

Power-Agitated, Absolutely Non-Coking

Ten and twenty-five barrel capacities. Twenty-five barrel kettle is completely insulated. Power agitation is mechanical, absolutely prevents coking under continuous service. Powered by Wisconsin air-cooled engine. Mounted on Athey tracks or steel skids. Safety type extracting valve, low center of gravity. Ten-barrel kettle mounted on steel wheels with 12" tread. These kettles will give less trouble, greater efficiency in your operation. To see one call Perrault Equipment Company.

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ALSO: Cleaning and Priming Machines and Coating and Wrapping Machines in both line traveling and stationary types. Patch Pots, Burners, and Accessories. Glass Pipe Wrap, Asbestos Felt Pipe Wrap, and Kraft Wrap. Rock Shield.

•

AND: Pneumatic-Tired Lowering-In Cradles, Adjustable Pipe Cradles, Five-Roller Cradles, Tongs, Sling Belts, and Hooks, Line-Up Clamps. Hand Tools. Supplies and Equipment of every sort.

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L. A. Bickel has been elected vice president of **Lone Star Gas Company** to succeed **Wesley F. Wright,** who retired. The company also has announced the election of **F. A. Garrett** as assistant general manager of the Dallas division to succeed Bickel. Garrett had been division purchasing agent and building manager for 14 years. Bickel entered the Lone Star system in 1925 as an employe of the Dallas Gas Company and, through a series of promotions, became assistant general manager of the Dallas division of Lone Star in 1954. Garrett joined the company in 1923 and since that time has served as clerk, assistant purchasing agent, and purchasing agent and building manager.

L. A. Bickel

•

W. A. Strauss has been named director of **Northern Natural Gas Company's** newly established Certificate department. The new department is primarily concerned with acquiring authorities from the Federal Power Commission in Washington, D. C. Strauss is a graduate of Iowa State College with a bachelor of science degree in general engineering, and has been associated with Northern since 1948 when he began working in the Engineering department. In 1951 he was transferred to the General department as staff assistant and in 1952 was promoted to administrative assistant.

W. A. Strauss

•

M. J. Casey has been named general superintendent of administration and industrial relations for operations for **Standard Oil Company (Indiana)**. Casey joined Standard Oil in 1932 as an accounting clerk in the Indianapolis sales division. He advanced through various positions and became assistant supervisor of labor relations at the Chicago general office in 1953. Since 1954 he has been administrative supervisor on the general manager's staff in the Supply and Transportation department.

SERVICE PIPE LINE'S 625-MILE "BIG INCH"

from Wyoming to Missouri contains 45,000 tons of NATIONAL SEAMLESS

Pipe welders at work on the rolling fields of Kansas.

USS National Seamless Pipe—45,000 tons of it—in sizes 20", 22", and 24" O.D. are now helping to carry millions of barrels of crude oil from the Rocky Mountain producing areas to midwest refining centers.

Starting at Fort Laramie, Wyoming, the new line runs through the Denver-Julesburg Basin of Colorado and Nebraska and is linked to west Kansas producing fields. It ties into Service Pipe Line Company's main North-South system at the western edge of Missouri.

The present outlet capacity is 160,000 barrels per day. It can be economically expanded to 245,000 barrels per day. Initially, more than 1,500,000 barrels of oil were required to fill the line.

The installation of this line brought about a new pipe-laying record—an average of over 10 miles a day. Eight spreads welded as high as 108.6 miles of pipe in one week, and up to 17.4 miles in a single day! This is a tremendous accomplishment in view of the fact that the line passes under 49 highways, countless roads, 21 railroads, eight major rivers, and spans innumerable irrigation ditches.

A section of 24" O.D. x .500" wall National Seamless Pipe, coated for the Solomon River crossing. The covering consisted of a dope primer impregnated with fibre glass paper and coated with two inches of cement.

This type of rugged service calls for exceptionally strong, uniform, flexible pipe that will endure crushing underground and underwater stresses. And most important — it must be pipe that can be depended upon to give long, trouble-free service. This is USS National Seamless Pipe, "Walls Without Welds" . . . and these are the reasons why it is chosen so consistently to do the job.

In Pipe Lines Too . . . Seamless Does It Better

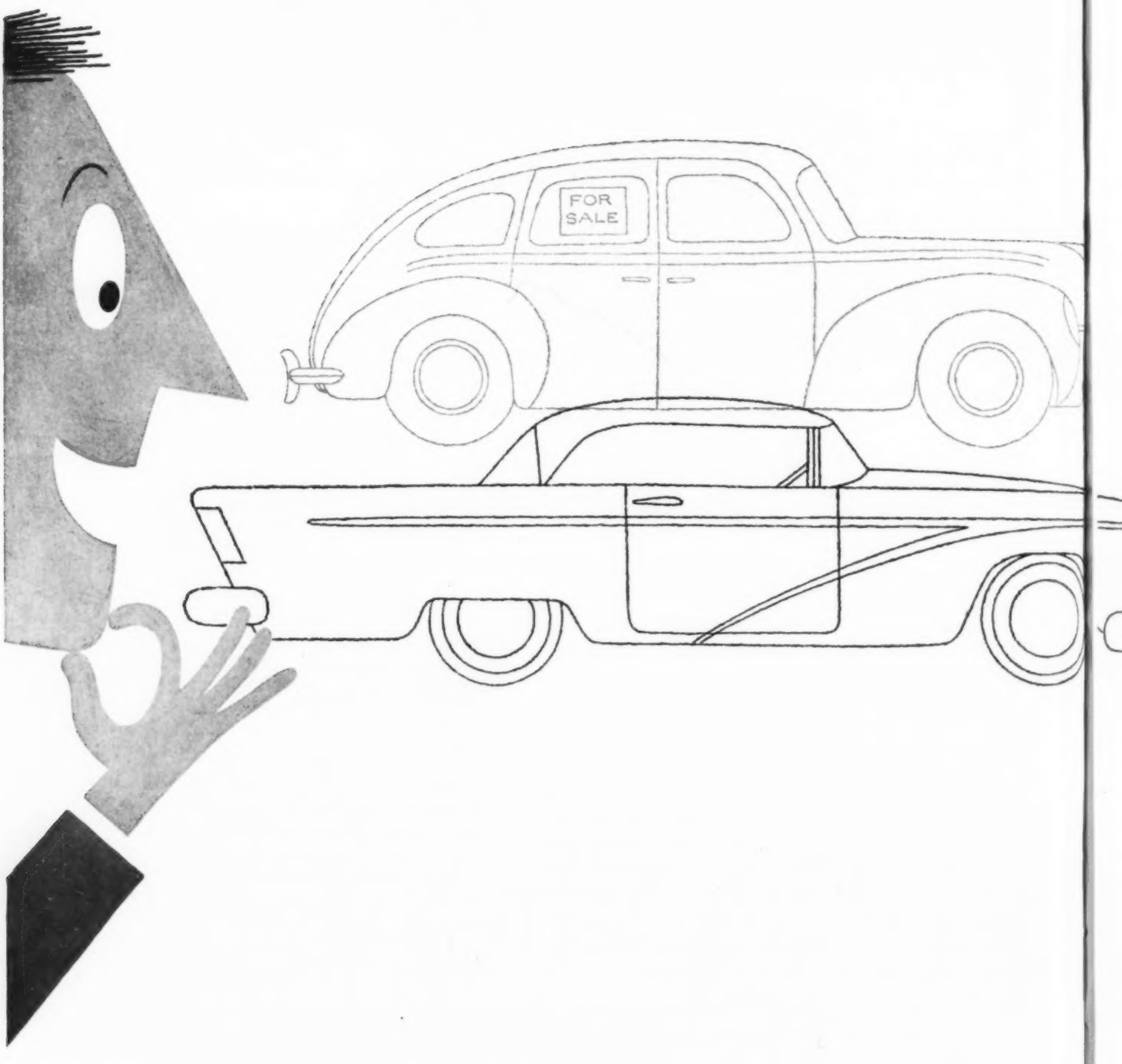
NATIONAL TUBE DIVISION UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS **NATIONAL SEAMLESS PIPE AND TUBES**

UNITED STATES STEEL

compressor designs also become



New automobile designs with startling advances in styling and performance present their appearance every year. Engines considered to be the last word a few short years ago, have been scrapped in favor of new models possessing greater performance and stamina.

Isn't there also a continuing need for improved compressor designs and performance . . . don't they too become obsolete?

obsolete!

To avoid owning a *new* plant that is an antique *before* it starts up, be sure that you insist upon modern compressors.

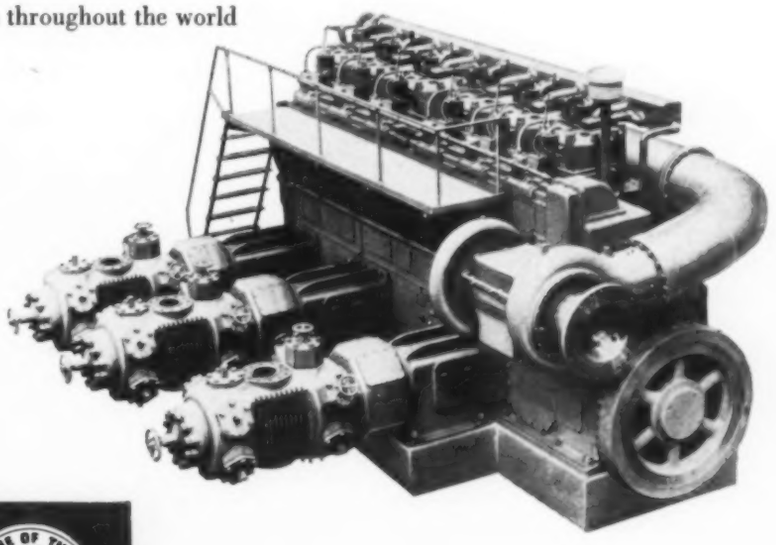
Clark is the only source of MODERN compressors that are specifically designed and built as turbo-supercharged units.

This means high power output—up to 65% more, without cutting into overload capacity or safety factor. Furthermore, a 10—15% reduction in fuel consumption plus a 40% saving in cooling cost is a direct result of turbo-supercharging.

Though Clark Model TLA and TRA Turbo-Supercharged compressors are modern designs, they have already been proved in numerous installations. They are built in 1100—3400 BHP models.

If you would like further details on the advantages of buying MODERN turbo-supercharged compressors to match your other up-to-date equipment and facilities, call your nearest Clark office or write for bulletins No. 134 and 145.

CLARK BROS. CO. • OLEAN, N. Y.
One of the Dresser Industries
Sales offices in principal cities throughout the world



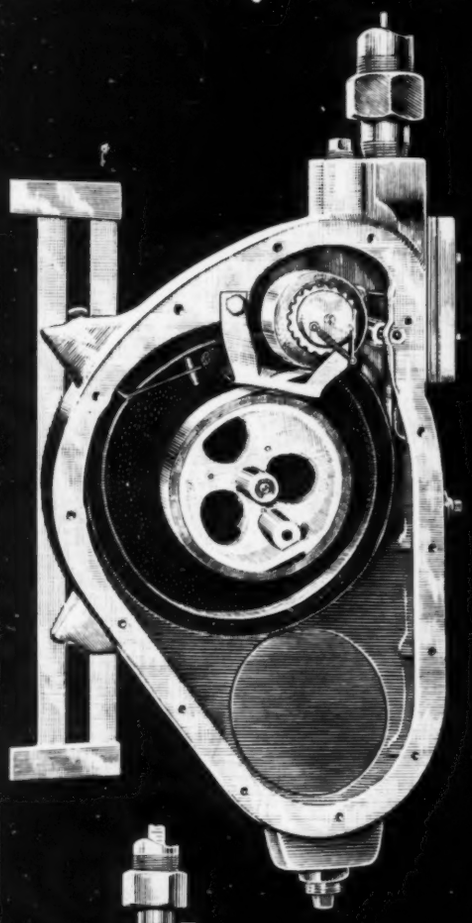
Clark Model TLA-6 2000BHP Turbo-Supercharged, 2-cycle, gas-engine-driven compressor

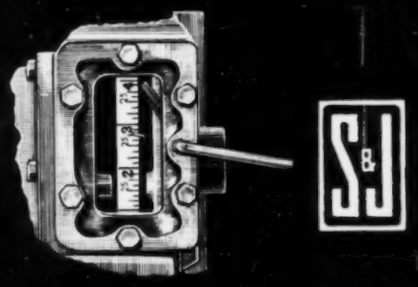
CLARK®

ONE OF THE DRESSER INDUSTRIES

Turbo-Supercharged Compressors

Anticipating YOUR NEED—





Anticipating the day when you may wish to convert all of your direct ground reading automatic tank gages to a remote reading system, S. & J. announces the new ST-8000 Automatic Tank Gage, designed with a gage head that will provide you with direct ground reading measurements TODAY, and will accommodate the necessary remote reading transmitter sprocket integrally. This will eliminate the purchase of a sprocket housing, and the nuisance and expense of its installation when the day comes that you wish to put remote gaging into effect. It enables you to enjoy all of the advantages of automatic tank gaging, with readings taken at each tank NOW, and makes it easier and less expensive when you decide to speed up with remote reading gages.

The S. & J. ST-8000 Automatic Tank Gage is the last word in tank gage development. It incorporates a Neg'ator motor to eliminate the counterweight and cable assembly, and provides constant tape tension throughout float travel, assuring maximum accuracy at all liquid levels. This gage will serve tanks to 65' in height, and with materially reduced bearing loads, will provide a minimum fatigue life of 13,000 cycles, equal to up and down twice a day for nearly 20 years. For complete information of the ST-8000 Automatic Tank Gage, write the factory or the nearest branch listed below.

Shand and Jurs Co.

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NEW YORK
342 Madison Ave.

HOUSTON
M & M Bldg.

TULSA
Thompson Bldg.

CHICAGO
10409 S. Western Ave.

LOS ANGELES
6399 Wilshire Blvd.

REPRESENTATIVES:

SEATTLE: Nebar Supply Company, 3000 Western Avenue
MONTREAL: Lytle Engineering Specialties, Ltd., 360 Notre Dame St., W.
TORONTO: Lytle Engineering Specialties, Ltd., 69 Eglington East
VANCOUVER: P. D. McLaren & Son, Ltd., 3277 Main Street
CARACAS: Sinclair Spence, C.A., Edificio Galipan
ENGLAND: Whessoe, Ltd., Sales: 25 Victoria St., London S. W. 1
Whessoe, Ltd., Works: Darlington, County Durham

Robert J. Fitzpatrick has been appointed director of public relations for **Texas Eastern Transmission Corporation.** He will be in charge of the company's public relations, publications and advertising. Prior to accepting his position with Texas Eastern, Fitzpatrick was vice president of Albert Frank-Guenther Law, Inc., a New York public relations counseling and advertising firm. He served that firm for 15 years, servicing major accounts in the complete range of advertising and public relations activities.

Robert J. Fitzpatrick

•

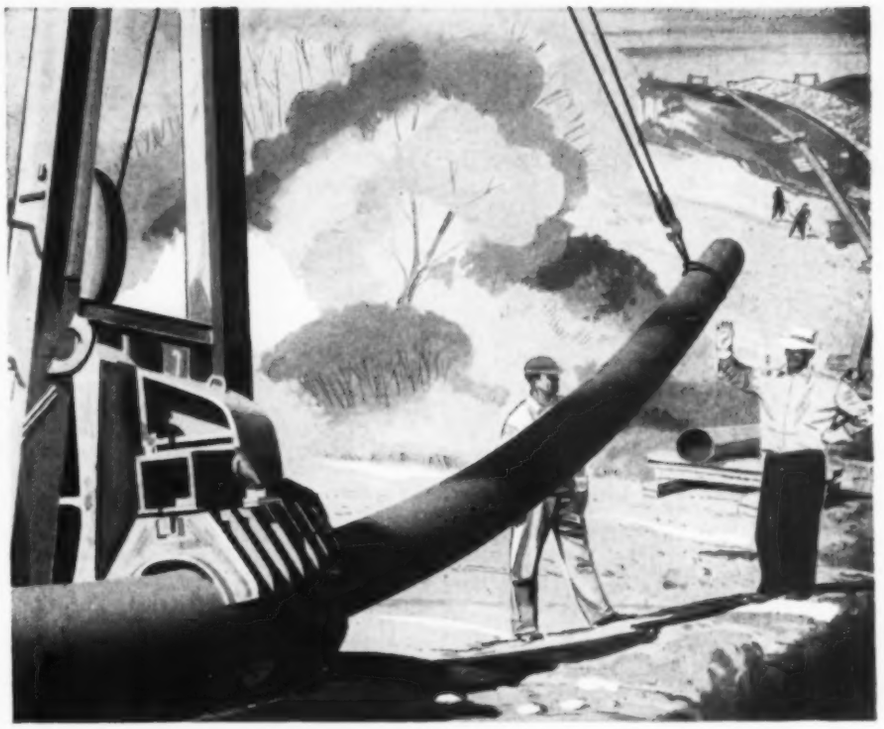
Jacob J. Schmidt, general production superintendent and assistant to the president of **The East Ohio Gas Company,** has been appointed manager, System Gas Supply for the Consolidated Natural Gas System effective January 1. His headquarters will be at Gateway Center, Pittsburgh, Penn. Schmidt will coordinate the production, transmission and storage of the gas supply for the entire consolidated system.

Jacob J. Schmidt

Schmidt's career with East Ohio began with a summer job in 1922 and 1923 as a surveyor while he was completing his education at Indiana University. In 1924 he joined the company as a geologist, working in the gas and oil fields in Ohio and Michigan. He became general production superintendent in 1932 and assistant to the president in 1951.

•

Charles E. Main has been named chief engineer of the Eastern Pipelines division of **Socony Mobil Oil Company Inc.** succeeding **George F. Brigance,** who has retired. Main has been superintendent of the Product Pine Line department, Central Pipe Line division in Topeka, Kansas, for the past three years. He has been associated with the Central Pipe Lines division for the past 20 years except for a short time in 1954 when he assisted in construction of a product pipe line in Australia.



Super bending quality and workability speeds construction . . .

Lone Star API Line Pipe

There's real economy and extra speed in construction when you use Lone Star pipe. Lone Star's convenient pipe inventories, the direct haul of the pipe from the mill, the stringing of the pipe along the right-of-way without rehandling, superior bending quality . . all these facts contribute to the sweeping trend to Lone Star.

Lone Star's vast, completely integrated steel plant was especially built for and dedicated to serving the dynamic oil and gas industries. Lone Star meets API specifications.

Neighbor, wherever you are, specify Lone Star . . and we both get a good deal!

Lone Star STEEL COMPANY

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For more data on advertised products, use Readers' Service Cards, last page.

What's Happening

AMONG SERVICE AND SUPPLY MEN

Richard W. Hoyt

Joseph C. Lepic

Hoyt and Lepic Receive C. Lee Cook Company Posts

The appointment of Richard W. Hoyt as assistant to the president of the C. Lee Cook Company has been announced. Hoyt will devote his time to the development of new markets and new products.

Prior to joining Cook, Hoyt was vice president and chief engineer of the Double Seal Piston Ring Company. Before that, he was with the Bendix Aviation Corp.

The company also announced the appointment of Joseph C. Lepic as sales engineer in the Wisconsin-Michigan-Chicago area territory. Lepic formerly was with the Armour Research Foundation, where he conducted research on diesel and gas engines. He also was a field engineer for the Cooktite Ring Sales Company, while this company acted as a national industrial sales outlet for the C. Lee Cook Company.

General Precision Acquires Shand and Jurs Company

An agreement has been reached for the acquisition by General Precision Equipment Corporation of a majority of the outstanding stock of Shand and Jurs Co.

Pioneer in the development of equipment related to the safe storage and transportation of volatile liquids, Shand and Jurs was organized in 1922. The company's products, ranging from simple hatch and manhole covers to complex electronic instruments, are sold principally to the petroleum and chemical industries in the U. S. and overseas.

Upon consummation of the acquisition, Shand and Jurs will join the GPE group of operating companies but will continue to be operated as a separate corporation under the present management. Officers include Albert E. Jurs, Sr., chairman of the board; Eugene E. Jurs, vice president; Albert E. Jurs, Jr., vice president; and Peter C. Jurs, vice president.

General Precision's subsidiaries, which totals 21 with the Shand and Jurs acquisition, produce precision products and controls for industry and defense.

Tracerlab Appoints Tittle Manager of Western Division

Tracerlab, Inc. has appointed Dr. Charles W. Tittle manager of its western division in Richmond, Calif.

Dr. Tittle, who received his Ph.D. in nuclear physics at Massachusetts Institute of Technology, was formerly head of the nuclear physics section, Gulf Research and Development Corporation. He has had experience in nuclear instrumentation and applications of radioactive materials in industrial processes.

Dr. Charles W. Tittle

Walsh Ends 30 Years Service With Universal Atlas Cement

Raymond L. Walsh, assistant vice president and chief engineer, has retired from Universal Atlas Cement Company after 30 years of service. He will be retained by the company in a consulting capacity.

Chester D. Rugen was appointed assistant vice president—engineering and Robert B. Jordan named chief engineer.

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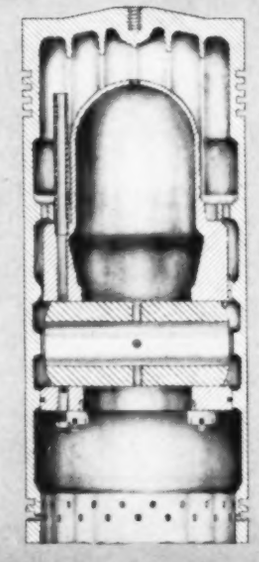
Let Us Give You The Facts About
NIMCO HANGER TYPE PISTONS
for ALL INDUSTRIAL ENGINES!



Successful users are the biggest boosters of NIMCO Hanger-Type replacement Pistons. If you operate large Diesel or Gas Engines, you should know their advantages too!

The NIMCO Hanger-Type Piston, incorporating a full-floating wrist pin, insures efficient oil cooling from below the pin to the top of the piston. This permits more uniform structural design of the piston body. No modification of companion parts is required for installation.

CALL OR WRITE TODAY FOR THE COMPLETE STORY!

NICKLES MACHINE CORPORATION
MANUFACTURERS — ENGINEERS
PONCA CITY, OKLAHOMA
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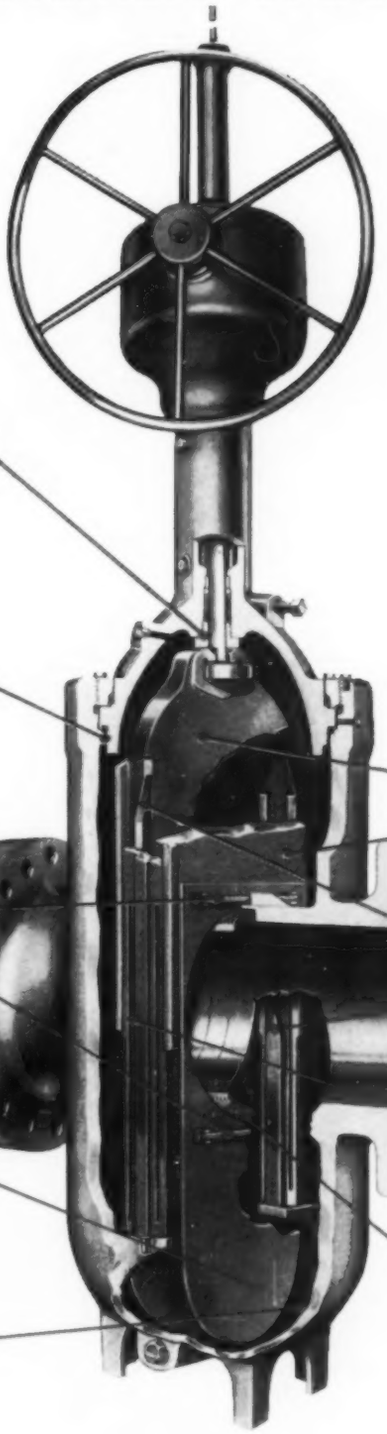
For Gas or Oil Pipelines . . .

HERE'S WHY OILMEN SPECIFY TYPE 49

Check these type **49** *features:*

- **Especially designed for pipelines handling crude oil, refined products, or gas.**
- **Easy passage for pigs or scrapers.**
- **No recesses to trap dirt.**
- **Install in any position, for flow in either direction.**
- **Complete line from sizes 2 to 30 inches in series 400 & 600.**

For more information, see your nearest Walworth Distributor or write to Walworth Company, General Offices, 60 East 42nd St., New York 17, N. Y. Ask for Circular 137.



Bonnet bushing screws into the bonnet and is tack-welded in place . . . guides the stem, also retains plastic packing which is adjusted by a packing screw.

Boltless, flangeless bonnet joint, sealed with ring gasket, stays tight at all pressures. This design saves room, weight.

Hard chromium-plated discs resist corrosion, abrasion.

Loading bars press disc shield plates axially to wipe discs clean while valve is closing or opening.

Leakproof closure, provided by wedging surfaces on each guide and sides of the discs. Wedging surfaces press discs against seat rings.

Disc shield plates contact disc faces at all times to prevent dirt from entering the body cavity.

Loading bars, incorporated on the disc guides, press the discs axially against the seat rings to provide wiping action between the disc and seat ring faces.

Valve needs no body-packing grease.

Backseated seat rings screw directly into body with perfect alignment. Stellite or bronze facing on ring.

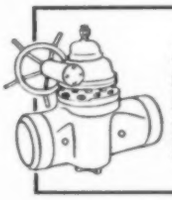
Cutaway of a 16-inch Walworth Type 49 Cast Steel Pipeline Gate Valve

WALWORTH

Manufacturers since 1842

valves . . . pipe fittings . . . pipe wrenches

60 East 42nd Street, New York 17, N. Y.
Walworth Company of Canada, Ltd., Toronto



For quick opening or closing Walworth manufactures lubricated plug valves for pipelines in sizes to 30-inches . . . pressures to 5000 psi and for vacuum service. Ask for literature.

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For more data on advertised products, use Readers' Service Cards, last page.

DARLING

DARLING

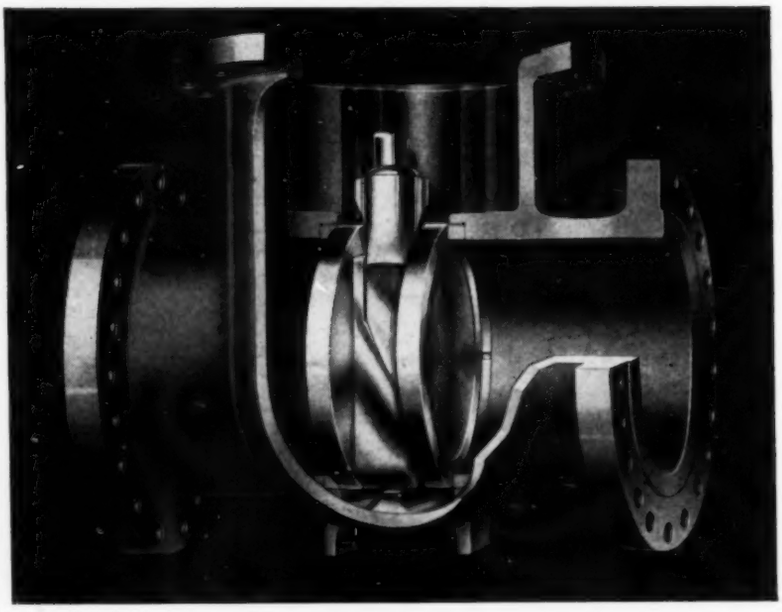
VALVES

What's *SURER* valve performance worth to you?

IN your service, the thing about valves that costs the most is down time. Right? And sometimes even *preventive* measures are pretty costly, too!

All right, here's a fact that Darling gate valve users everywhere will vouch for. The Darling *fully revolving double disc, parallel seat principle* means *easier* operation, *surer* closure, less chance of trouble, month in, month out. And you'll save on maintenance all along.

Why not check into Darling gate valves for your requirements? Find out *how* they assure these advantages. We'll gladly furnish general or specific details. Just say the word.



Above top: Darling 30" motor-operated gate valve powered by gas from line pressure.

Cutaway, below, shows simplicity of Darling's unique fully revolving double disc parallel seat gate valve principle—just four simple working parts—two plain interchangeable no-pocket discs and two husky wedges.

DARLING VALVE & MANUFACTURING CO.

Williamsport 27, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ontario

W. N. Brown

J. D. Harrison, Jr.

Mission Manufacturing Men To Spend 6 Months in Ireland

W. N. Brown, design engineer, and J. D. Harrison, Jr., technical assistant, for Mission Manufacturing Company are being transferred to Mission Manufacturing Company Ltd. of England to help supervise the setting up of the new Mission plant in Belfast, Northern Ireland. They plan to be in Ireland for about six months.

They will work under the direction of R. H. Anschutz, manager of the United Kingdom Company and liason between the Houston and British plants.

Brown will be generally responsible for getting the plant in operation; Harrison will supervise the tooling and inspection phases.

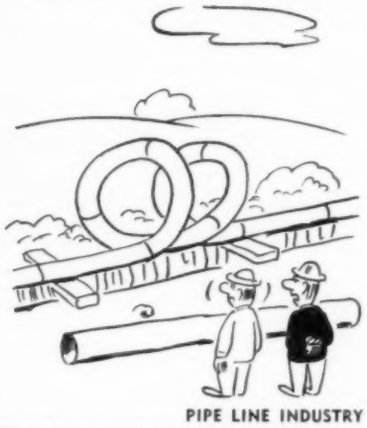
American Bosch Arma Names Jay Assistant to Vice President

Richard S. Jay was appointed assistant to vice president-sales of American Bosch Division of American Bosch Arma Corporation.

Richard S. Jay

Jay was formerly sales manager of the Buckeye division of Gar Wood Industries at Findlay, Ohio, manufacturers of construction equipment. He had been associated with Buckeye for seven years and left that organization to accept the above position with American Bosch.

Previous to his association with Gar Wood Industries, Jay was with Consolidated Vultee Aircraft and Columbia Studios, California, in various capacities.

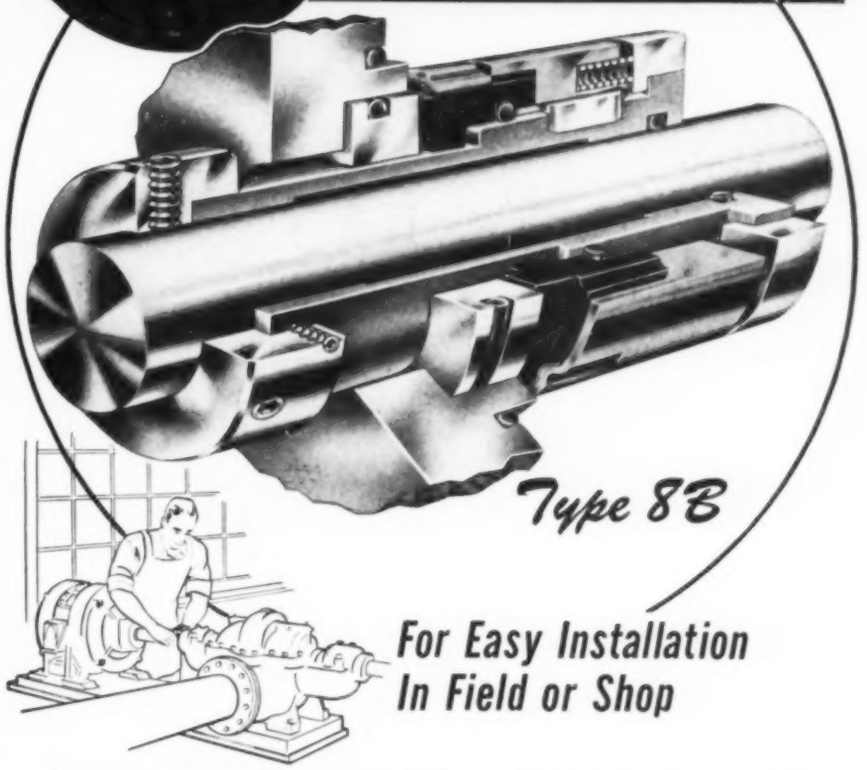


PIPE LINE INDUSTRY

"Mighty expensive sense of humor you've got, Ed. All I can say is—you're fired!"

JOHN CRANE

PACKAGED TYPE MECHANICAL SEALS FOR High Pressure Pipe Line Pumps



Type 8B

For Easy Installation In Field or Shop

Manufacturers of large centrifugal pumps and pipe line operating engineers have long been asking for an end face mechanical seal meeting these requirements: 1) heavy-duty design to handle high pressure applications; 2) single-unit packaged construction for easy installation; 3) a full range of sizes to meet individual specifications.

"John Crane" has met this need with the Type 8B hydraulically balanced seals for pressures to 1200 psi.

These seals can be quickly installed and adjusted simply by sliding the entire unit along the shaft into final position. Removal of the top casing is not necessary. This feature alone results in the saving of many man-hours of maintenance work.

Field reports and performance records point to the steadily increasing use of "John Crane" high pressure seals to eliminate problems connected with the handling of hydrocarbons, crudes, gasoline and other petroleum products.

To help you in your individual requirements, "John Crane" offers nationwide service—available without obligation from strategically located factory owned branch offices.

Write for illustrated high pressure seal bulletin.

Crane Packing Co., 6434 Oakton St., Morton Grove, Ill., (Chicago Suburb).

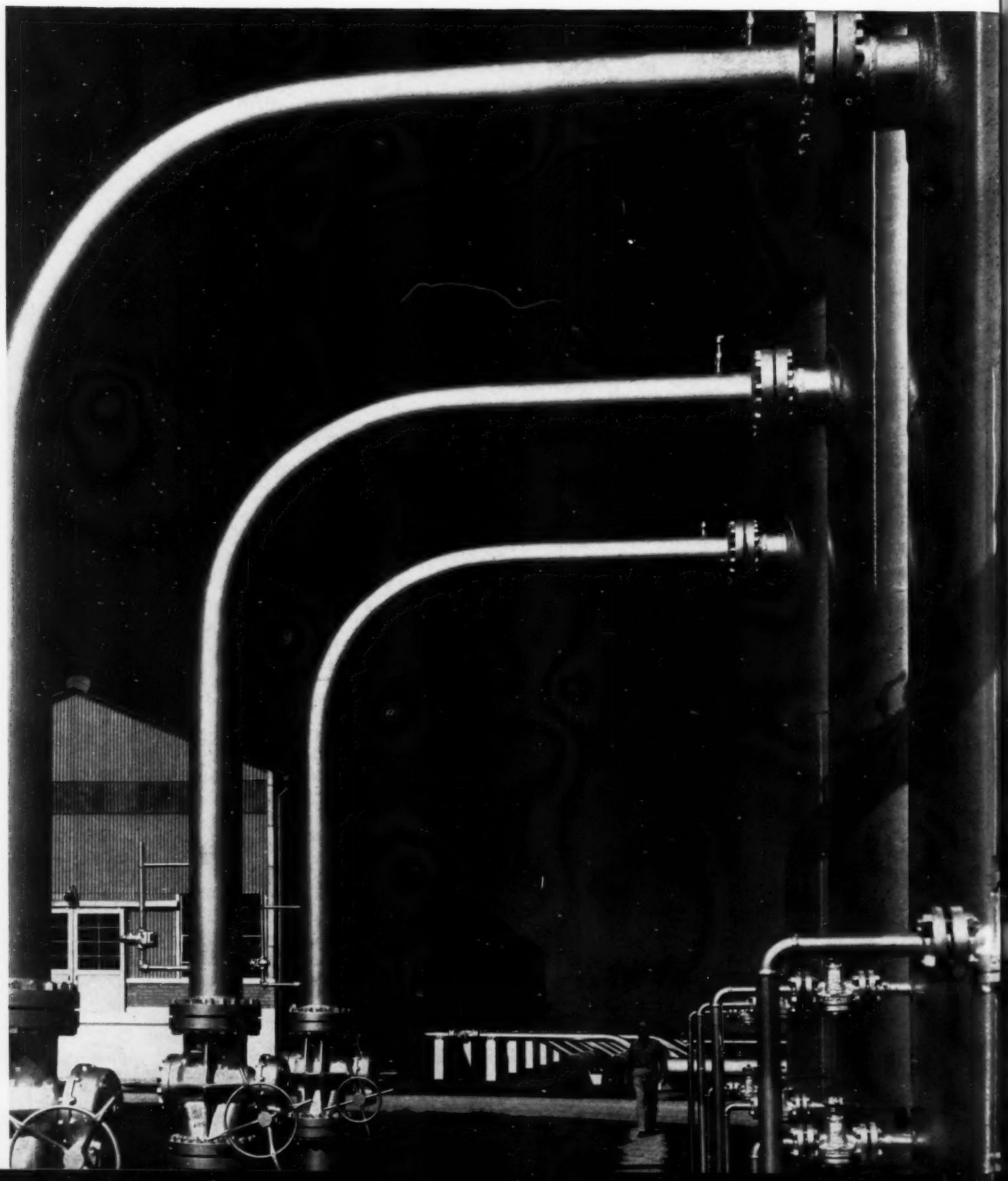
In Canada: Crane Packing Co., Ltd., 617 Parkdale Ave., N., Hamilton, Ont.

JOHN CRANE CRANE PACKING COMPANY

For more data on advertised products, use Readers' Service Cards, last page.

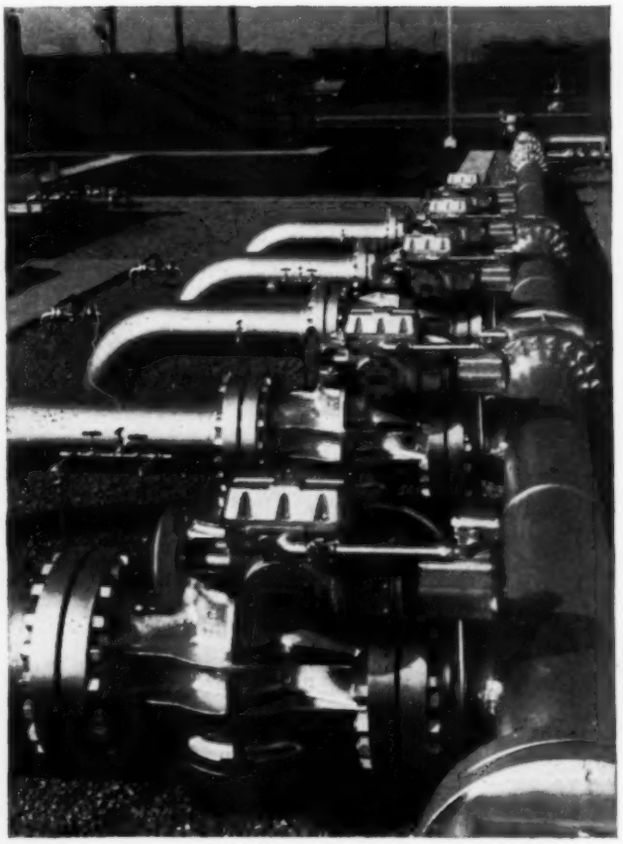
Reliability =

ROCKWELL-Nordstrom VALVES



Profitability

Keep pipelines profitably on stream



Valve down time often plays a large part in the profitability of gas, petroleum and products pipelines. Years of exceptional performance records and cost studies prove that Rockwell-Nordstrom valves are the best way to keep profitably on stream. Here are three reasons why you see so many Rockwell-Nordstrom valves on so many pipelines:

LEAKPROOF SAFETY: Pressurized lubricant sealing eliminates risky "forced" seating . . . prevents internal or external leakage of lightest gases or heaviest liquids.

FAST, DEPENDABLE: Quarter-turn closure . . . lubricant jacking for instant operation . . . power operation is simpler, less costly.

ECONOMICAL: First cost is no higher (often lower) than ordinary valves . . . elimination of metal-to-metal wearing friction and unexposed seats assure low maintenance and long life.

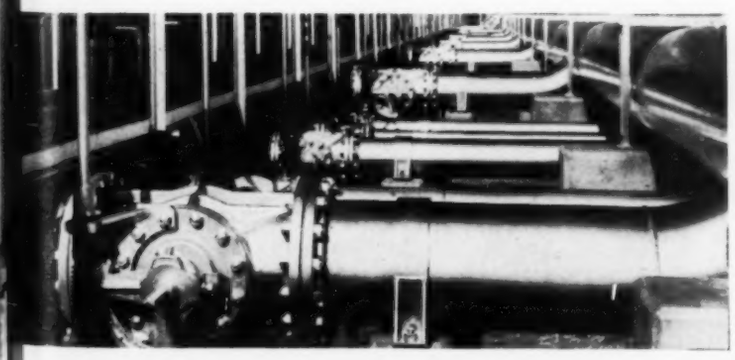
Rockwell-Nordstrom valves are available in a complete range of sizes and pressure ratings in steel, semi-steel and corrosion resisting metals. For more information, see your nearest supplier or write: Rockwell Manufacturing Company, Pittsburgh 8, Pa.

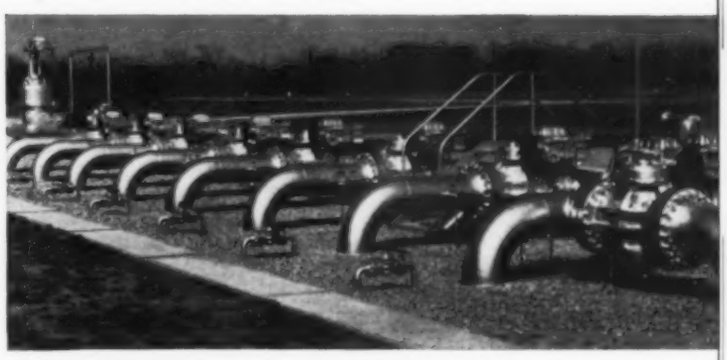
Canadian Valve Licensee: Peacock Brothers Limited

40th YEAR *of lubricated plug valve leadership*

ROCKWELL-
Nordstrom
VALVES

Lubricant Sealed for Positive Shut-off





Ever read a guarantee to beat this?

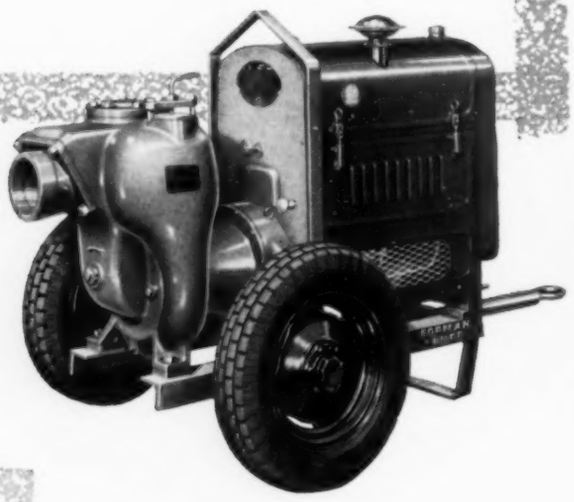
GORMAN-RUPP PUMP *Guarantee*

Our distributors are authorized to put a Gorman-Rupp Self-Priming Drainage Pump on any job, any time, anywhere alongside any other make of pump, size for size.

The Gorman-Rupp Pump is guaranteed to pump more dirty water, more hours, using less gasoline and to prime quicker than any other self-priming pump.

If it isn't the best all-around pump, our distributor will accept the return of the Gorman-Rupp Pump and pay any pump installation expense incurred.

THE GORMAN-RUPP COMPANY
Mansfield, Ohio



Sizes 1½", 2", 3", 4", 6", 8", 10".

Every pump covered by this plain-language guarantee!

Gorman-Rupp PUMPS

Write for Bulletin No. 5-OF-11

Mid-Continent & Gulf Coast Oil Field Representative

HENRY H. PARIS DISTRIBUTOR, INC.

1125 Rothwell St., Houston, Texas

Herbert E. Barth

Edwin W. Petersen

American Blower Announces Personnel Appointments

Herbert E. Barth has been named to the newly-created position of executive vice president of American Blower Corporation. Edwin W. Petersen is appointed vice president-sales, of the corporation, succeeding Barth. Petersen formerly was sales manager of American Blower.

Two executive appointments for Canadian Sirocco Company, Limited, a subsidiary of American Blower, also were announced. Clarence W. Johnson, presently vice president and general manager of Canadian Sirocco, will become president of the Canadian company. Richard R. Noyes, now sales manager, will become vice president-sales.

Barth joined American Blower as an engineer in 1915. He entered sales work for the company in 1916, becoming vice president-sales, in 1937.

Petersen joined American Blower as a sales engineer in 1923. He served in various sales and management positions before his appointment as sales manager in 1952.

Mel Maddox Is Sales Manager Of Pipelife Corporation

Mel Maddox has been appointed sales manager of Pipelife Corporation. The firm recently moved its national headquarters from Texas to Tulsa.

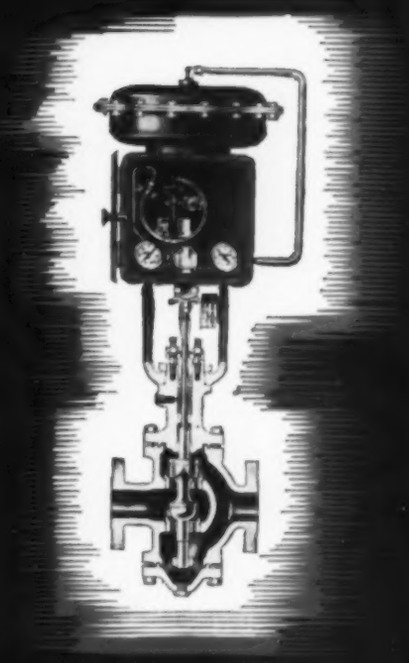
Mel Maddox

Maddox has been in the pipe line industry more than ten years in sales and service of protective coatings, pipe line supplies and equipment. Previously he was district manager of Pittsburgh Coke and Chemical in Atlanta, Ga., and was five years with Reilly Tar and Chemical Corporation.

MacDonald Retires From Post With U. S. Steel Corporation

J. Carlisle MacDonald has retired as assistant to the chairman of the board in charge of public relations. MacDonald organized U. S. Steel's public relations department in 1936 and has been in charge of the department since that time.

Three members of the public relations staff have been advanced to new positions. Phelps H. Adams becomes executive director—public relations and assistant to the chairman of the board; Charles W. Huse takes over the duties of director—public relations administration, and Fred LePell moves up as assistant director—public relations administration.



FISHER WIZARD - - - UNIVERSALLY ACCEPTED AS THE WORK HORSE ON PRESSURE CONTROL JOBS

FISHER GOVERNOR COMPANY • Marshalltown, Iowa

WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

Walworth Company Purchases Southwest Fabricating

Purchase of the assets and business of the Southwest Fabricating & Welding Co., Inc., Houston, by the Walworth Company has been announced.

Fred W. Belz, president of Walworth, announced that 107,039 shares of common stock of Walworth were exchanged for Southwest Fabricating.

Southwest Fabricating supplies markets throughout the world in the oil, chemical, petrochemical and natural gas fields. Belz said Southwest will be operated as a subsidiary of Walworth, retaining present management and employes and continuing present policy.

Walworth, with sales in excess of $42 million annually, recently completed the purchase of two additional manufacturing companies, the M & H Valve and Fittings Company, Anniston, Ala., and the Alloy Steel Products Company, Linden, N. J. These acquisitions are part of Walworth's planned expansion and diversification program.

Two Directors of Atlas Powder Retire; New Member Named

Charles Warner, a director of Atlas Powder Company since 1927, and Cecil F. Backus, director since 1929, have retired. The company has announced the election of Wilfred D. Gillen, president of The Bell Telephone Company of Pennsylvania and The Diamond State Telephone Company, as a new director.

John B. Laramy

Alvin F. Welsh

Laramy and Welsh Receive Promotions at Worthington

John B. Laramy has been appointed assistant general sales manager of Worthington Corporation and Alvin F. Welsh has been named manager of the Marketing Research department.

Laramy joined Worthington in 1929 and has served as an application engineer, general line salesman, and assistant district office manager. In 1951 he was appointed manager of the Marketing Research department.

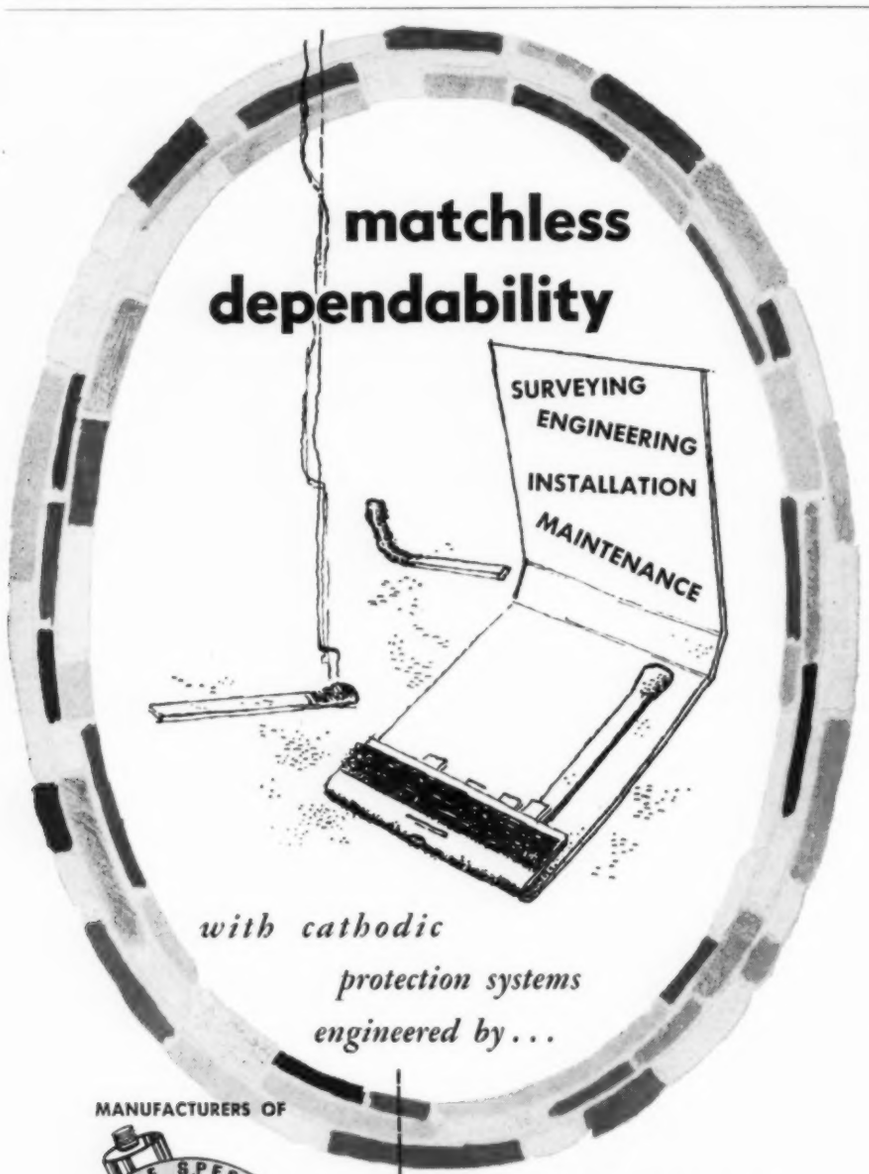
Welsh joined the company in 1925 in Tulsa and later served in district offices as a general line salesman until 1942 when he joined the reciprocating pump division, of which he became manager in 1948.

Continental Supply Assigns Hambric to New Position

The Continental Supply Company has announced the appointment of Roscoe O. Hambric to the newly-created position of general merchandise manager. Since the latter part of 1954 he had served as assistant division manager of the Kansas-Oklahoma division, with headquarters in Tulsa.

In his new position he will have headquarters in the Dallas, Texas home office of Continental. Hambric will supervise and direct the operations of the Purchasing, Material Control and Traffic departments in the Dallas office, and additionally will coordinate, in collaboration with divisional management, all divisional merchandising functions.

Hambric started with Continental in the Seminole, Okla. store in 1946. He since has held positions as city salesman, store manager, assistant district manager and district manager.



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HIGH QUALITY ANODES

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Pipeline Supply Co.
912 West 11th
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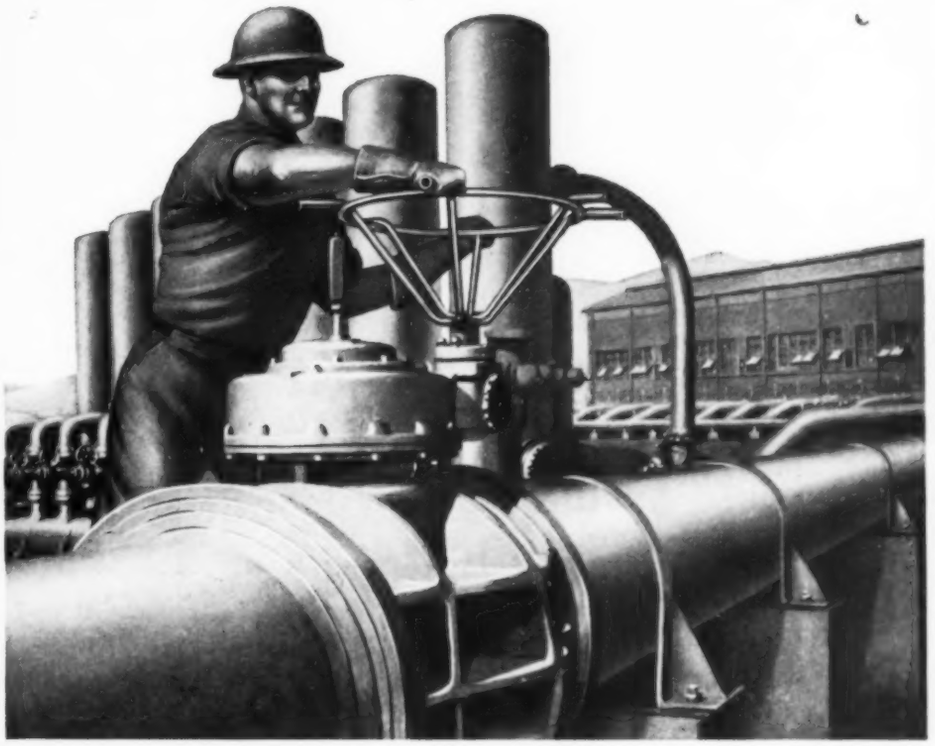
Order Your Copy of 1955 Pipe Line Industry Index

The complete editorial index covering all issues of PIPE LINE INDUSTRY published during 1955 has been prepared and is bound separately in convenient pamphlet form. It will be sent free to all subscribers who write requesting copies.

Use the Readers' Service postcard, last page this issue, to order your index. Or address orders to Librarian, Gulf Publishing Company, Box 2608, Houston 1, Texas. The supply is limited.



TURN UP THE HEAT...
more gas is on the way

1.7 BILLION cubic feet of natural gas!

That's what Tennessee Gas pipes daily to Eastern homes and industries. And still they call for more. To meet that steadily increasing demand, we recently completed a thousand mile loop linking the New York City area to our expanding 9000 mile system.

Huge underground storage fields close to consuming markets further assure dependable supply during peak winter demand. In the gas-producing Southwest a reserve of 12 trillion cubic feet! And new reserves added each year.

More heat, America? Turn it up. Tennessee Gas can deliver.

Industry joins the homeowner in the swing to natural gas. More and more processes that require precise, easily controlled heat find the answer in this superior fuel

TENNESSEE GAS
TRANSMISSION COMPANY
AMERICA'S LEADING TRANSPORTER OF NATURAL GAS
HOUSTON, TEXAS

One of a series of advertisements appearing in full color in national publications.

More Light on Heat — TGT advertisements like this spotlight the achievements of the natural gas industry.

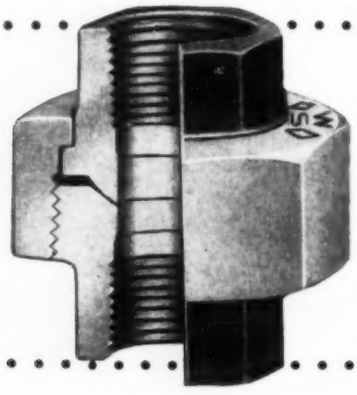
Tell how that industry harnessed a great natural resource, once wasted, and put it to work. Show what the industry has done ... and is doing ... to make this superior fuel and its better living available to more millions.

It's a continuing and dramatic story that benefits producer, transporter and distributor alike.

TENNESSEE GAS TRANSMISSION COMPANY
HOUSTON, TEXAS

W-S FORGED STEEL UNIONS...

These Features are YOUR GUARANTEE of a Safe, Tight Union Connection:



1. FORGED STEEL CONSTRUCTION— ASTM A-105, GRADE 2
2. SPHERICAL-TO-ANGLE MATING SURFACES
3. ANTI-GALLING, CADMIUM-PLATED NUTS

W-S Forged Steel Unions give you the kind of protection you need in high pressure piping systems. They're designed with precision-machined spherical-to-angle mating surfaces for positive seating, free from leaks even when pipes are slightly out of line. Cadmium-plated nuts resist galling and seizing and forged steel construction gives you the extra strength you need in high pressure service.

W-S Unions are available in 3000 lb. class, sizes ⅛" to 3" in screw-end and socket-welding types. Send today for your copy of Bulletin U-1.

Sold Through Leading Distributors.

W-S FITTINGS DIVISION

H. K. PORTER COMPANY, INC.
Roselle, New Jersey

Horth Is Assistant Manager Of De Laval Compressor Sales

John D. Horth has been appointed assistant manager of the Compressor Sales department at De-Laval Steam Turbine Co., Trenton, N. J.

John D. Horth

Horth joined De Laval in 1947. He served in the Chicago sales and service headquarters until 1949, when he was named district manager of the St. Louis office. In 1951 he was transferred to the Compressor Sales department in Trenton.

Pittsburgh Coke Reassigns Himmelrich and Ellis

The Protective Coatings division of Pittsburgh Coke & Chemical Company, has announced two new sales assignments for its pipe line enamels and cold coatings.

J. E. Himmelrich has been reassigned from Pittsburgh to the Tulsa office, and will represent the division in the states of Oklahoma, Kansas, Nebraska and Colorado.

M. P. Ellis has moved to the company's Pittsburgh office and will cover the territory formerly assigned to Himmelrich, consisting of Ohio, Kentucky, West Virginia and western Pennsylvania.

Rockwell Manufacturing Names Diamond Personnel Manager

John Robert Diamond, manager of procurement and selection for Pennsylvania Salt Manufacturing Company since 1950, has been named to the newly created position of personnel manager of Rockwell Manufacturing Company.

John R. Diamond

The personnel office, previously a part of the industrial relations department, will now operate as a separate department under Diamond.

Oil Well Supply Announces Personnel Appointments

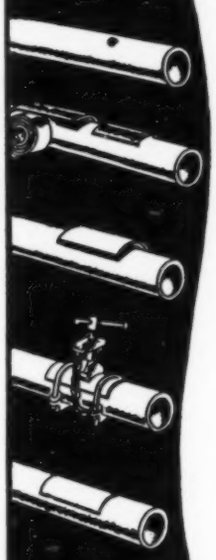
U. S. Steel's Oil Well Supply Division has announced a series of personnel changes.

Oliver E. Trechter, Jr., formerly assistant district engineer at Los Angeles, is named district representative at Long Beach; Carl L. Schwab, Jr., changes from field representative and store manager to district representative; Amos L. Cook, Jr., was named district representative at Bakersfield; and Bobby Gene McDonald named field representative at Hobbs, N. M.

The company also appointed Byron C. Hoffman as store manager of the Grandville, Mich., store and Richard A. Bokenkamp was named to a similar position at Charleston, W. Va. Field representatives in the Gulf Coast area are James S. Necessary, Lake Charles; and Robert E. Beattie, Beaumont, Texas.

NOW! Fits Up to 30" CASINGS

TO STOP PIPE-LINE LEAKS Simply-Quickly



DALLAS GRO-CORD GASKETS now offer the complete pipe-line gasket service. Formerly up to 10", GRO-CORD'S new stock is now made UP TO 30 INCHES in two sections—flat and crown stock plied together to insure **safe, extra-tight** sealing.

Easy to Apply . . .
They Last for Years

(a) Regardless of size of leak, just cut GRO-CORD gasket to cover generously . . . (b) Cut a piece of plate (half sole or sleeve) to extend about 1" on both sides and ends of gasket . . . (c) Fit plate over gasket so as to extend beyond gasket on all sides . . . (d) Clamp repair tight with a chain jack to shut off the leak . . . With clamps, hold plate in contact with pipes at all points. Weld all around and REMOVE CLAMPS. GRO-CORD gaskets have been in service up to 5 years before permanent or final weld was made. Tested at 1600 lbs. p.s.i., oil resistant, cotton impregnated GRO-CORD gaskets last for years. 15 years exclusive use by major gas distributing company. Write for literature. Jobber inquiries invited.

Distributed By:
Oilwell Supply Division of United States Steel Corp.
Iverson Tool Company • Norvall-Wilder Supply Co.

DALLAS
GRO-CORD
PIPE REPAIR GASKETS
DALLAS MANUFACTURING & SALES COMPANY
POST OFFICE BOX 7181 DALLAS 9, TEXAS

40 YEARS EXPERIENCE
. . . 40,000 MILES . . .
PIPELINES are NOT sidelines with . . .

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So SIMPLE that "Specials" are Likely to be Standard!

A sleeve, raised and lowered within a non-magnetic tube, attracts or releases an Alnico magnet attached to a mercury switch. Basically, this is Magnetrol

MAGNETROL

The World's Most Dependable

LIQUID LEVEL CONTROL

Because of the utter simplicity of Magnetrol's magnetic operating principle, standard models can be easily adapted to meet any special requirements for pressure, temperature or corrosive liquids . . . and usually at little extra cost. This Magnetrol versatility has solved all kinds of tough level control problems . . . and given our engineers wide application experience that can be invaluable to you.

Magnetrol is so simple that failure is all but impossible! Using only permanent, unfailing magnetic force for its operation, there's nothing to wear out . . . no diaphragms or bellows to stiffen and rupture . . . no electrodes to short or corrode . . . no packing to bind or leak. Magnetrol is practically maintenance-free! Magnetrol units are available for controlling level changes from .0025-in. to 150-ft. . . . with multi-stage switching when desired. Send coupon for full details.

MAGNETROL, Inc.

Send Coupon For Full Details

MAGNETROL, Inc., 2128 **S. Marshall Blvd., Chicago 23, Illinois**

Please send me catalog data and full information on Magnetrol Liquid Level Controls.

Name_____

Company_____

Address_____

City_____ Zone_____ State_____

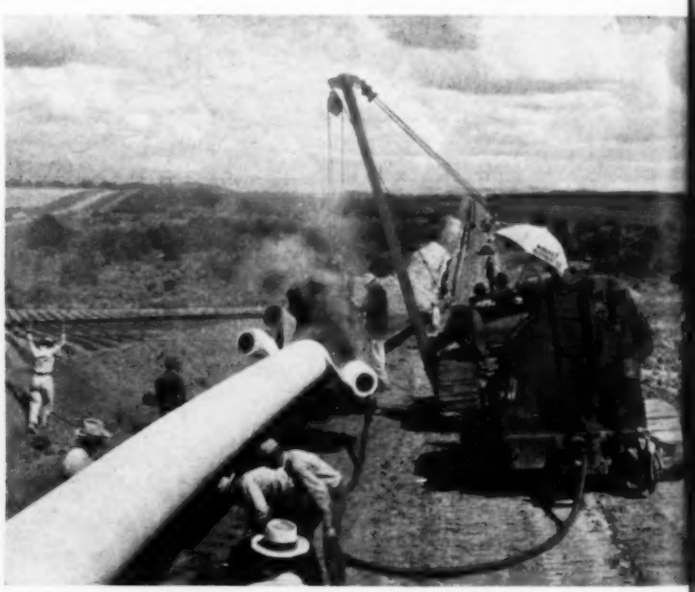
A PICTURE REPORT OF HOW

River Construction Co.

speeds important new 150-mile gas line

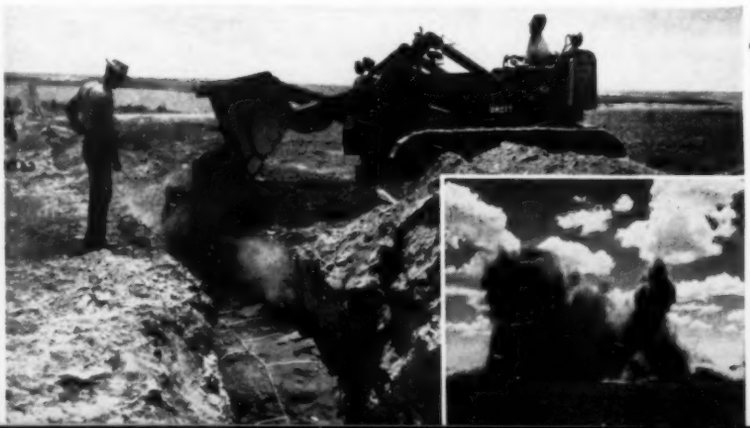
River Construction Co., Fort Worth, Texas, is now laying an important new line which will send natural gas from the San Juan Basin, Colorado, to the industrial areas of the Pacific Northwest. Their first contract calls for 150 miles of 26-inch line between Ignacio, Colorado, and Moab, Utah. Large photo at right shows two of the company's International TD-24's with Superior Booms lowering a 200-ft section of pipe across an irrigational canal. Note how two-way powered line enables operator to inch this long, heavy section into place without danger of slipping. All controls are grouped for operator's convenience and safety.

At bending machine, River Construction Company uses another International tractor—this TD-18A with Superior Boom. Fast-maneuvering unit carries pipe so rapidly to and from bending machine it has time to transport River's 200 and 300 amp welders from place to place, as needed.



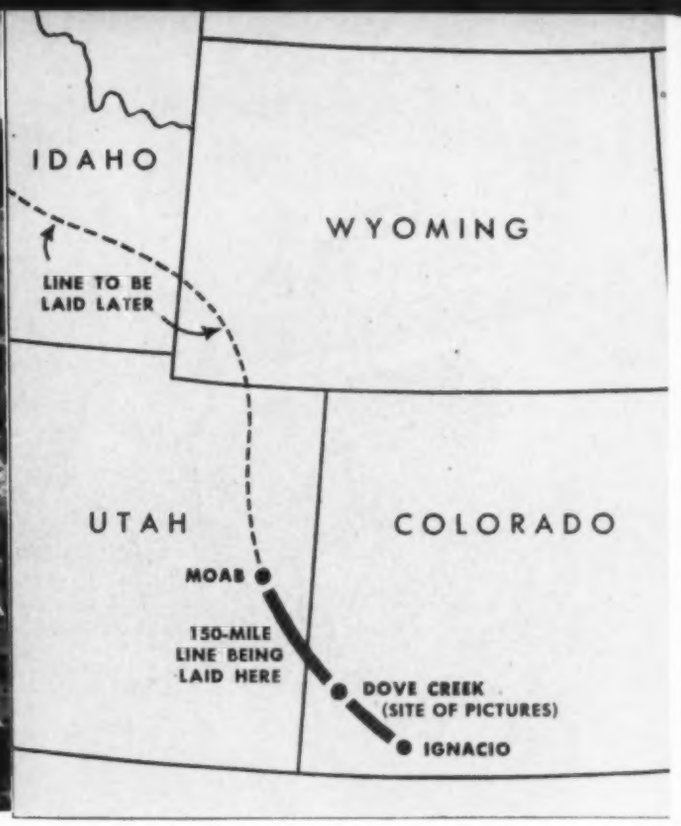
For doping and wrapping, another International TD-24 wit Superior Boom carries weight of pipe, pulls dope and wrap machin *and*, at same time, tows heavy, crawler-mounted dope pot!

Hand Mode in firs



To prevent scattering of blasted rock over farm fields, TD-14A dozes dirt over dynamite. Explosion expends force moving dirt; rock stays within right-of-way.

Final cover is handled by TD-14 with bucket-backfiller. Operato say they like the easy, effortle control and good all-around visi of both tractor and bucket.



Hand-patching is handled by this TD-18A tow tractor and crew. Model shown develops 102 bhp . . . 89 drawbar . . . pulls 22,850 lbs in first gear . . . has 6 speeds up to 5.7 mph.

To prevent damage before final backfilling, two International Drott TD-14A Skid-Shovels place blanket of rock-free earth around pipe. These rigs develop 66 dhp, handle 3 yds per load.

makes every load
. . . a payload . . .

INTERNATIONAL HARVESTER

International Superior

INTERNATIONAL HARVESTER COMPANY
180 North Michigan Ave. • Chicago 1, Illinois

A machine size for every job . . . see your nearest INTERNATIONAL INDUSTRIAL POWER DISTRIBUTOR for details.

Lift capacities increased 20 to 62%

	TD-24	TD-18A	TD-14A	TD-9
Lift capacity of New Superior Booms*	110,000	70,000	30,300	16,000
Lift capacity of '54 models*	90,000	43,200	24,300	13,440
New Superior Booms give you these per cents of increase	22%	62%	25%	20%

*Figures show maximum lift in lbs at d'overhang

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LOW COST
CORROSION
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of

OIL WELL CASINGS
SHORT PIPE LINES
HEAT EXCHANGERS
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SERVICE STATIONS

or any buried or submerged metal structure where low amperage is required to prevent electrolytic corrosion. Adaptable for a wide variety of uses where economy is dictated. Available for quick delivery in sizes 110/220/440 volts A.C., 12 to 48 volts D.C., and 3 to 6 amperes D.C.

A COMPLETE LINE OF QUALITY MATERIALS

in stock, including: Copper Cable • National Carbon Company Anodes • Vibroground Soil Instruments • M-Scope Pipe Finders • "Coreco" Rectifiers, all sizes • Potentiometers and Interruptors.

WHEN YOU THINK OF CORROSION, CALL

Coreco

FOR POSITIVE CORROSION CONTROL

A Complete Design and Installation Service

Call, wire or write today to

CORROSION RECTIFYING *Company*

1506 Zora Street • Houston, Texas

Midwest Piping Names Becker General Manager of Sales

Phil R. Becker has been named general manager of sales by Midwest Piping Company, Inc., St. Louis. A graduate of Washington University, Becker has served with Midwest since 1939. In 1949 he became sales manager of the company's Welding Fitting division. In his new position he will have over-all responsibility for the national sales program of all divisions of the company.

Phil R. Becker

Clark Bros. Names McCartney To Head Overseas Work

Robert R. McCartney has been appointed vice president in charge of overseas operations for Clark Bros. Co., one of the Dresser Industries.

McCartney will devote his time to the company's expanding overseas operations including registered foreign offices, a large number of manufacturers' agents and three licensed overseas manufacturers of Clark engines and compressors.

R. R. McCartney

In 1937, McCartney took a position with Clark as a sales engineer. Subsequently, he was named to various management positions in the New York district. In 1953 he was appointed eastern regional sales manager and director of export operations.

Rockwell Opens Denver Office With Cochran as Manager

Rockwell Manufacturing Company's Meter and Valve division has opened a branch office at 1421 Mile High Center Building, Denver, and has named Orville Cochran branch manager.

Orville Cochran

Cochran, a native of Livingston County, Missouri, has been a sales engineer for Rockwell in the Rocky Mountain territory for more than 25 years. He joined the company in 1922, spending eight years in the Kansas City district office. He has lived in Denver for the past nine years.

Houston Shipping Firms Open New York Office

Lee Construction Corporation, export crating firm; Lee Shipping Company, foreign freight forwarders; and the Lee Corporation, crane and industrial rental equipment, Houston, have announced the expansion of their present facilities to better serve the requirements of New York area clients by opening a New York office.

John W. Reagan, formerly outward freight manager for Fern-Ville Far East Line's Gulf-Far East service, manages the New York office at 21 West Street. Reagan also served in the U. S. Maritime Service after having been affiliated with Getz Bros. and Company and Ford Motor Company.

Personnel Appointments Made by Oil Well Supply

U. S. Steel's Oil Well Supply Division has announced several personnel changes. Robert B. Kennedy was named store manager of the Russell, Kansas store; Thomas A. Hopkins named district representative at Pettus, Texas; Harold W. Scott becomes district representative at Avenal, Calif.; and Carl R. Nelson made district representative, refinery and pipe line sales at Charleston, W. Va.

See Composite and Refinery Catalogs, or Write for Specifications Folder

FLEET-LINE®

PIPE SADDLES AND REDUCERS

Nozzle sizes from ¼" to 24"

ASTM A234

Also for pressure vessel heads

Nominal pipe sizes 1" to 30"

ASA B16.9
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Special sizes and lengths. Schedules 10 to 160 Stainless Steel, and other Alloys.

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ORGANIZED IN THE INTEREST OF GREATER SERVICE TO THE PETROLEUM INDUSTRY

For more data on advertised products, use Readers' Service Cards, last page.

What's New in Equipment

for the Pipe Line Industry

Rock Rippers

Wadsworth Manufacturing Company has introduced a rock ripper designed especially for road and dam construction work. The ripper is attached to a standard tractor and may be easily installed or detached on the job.

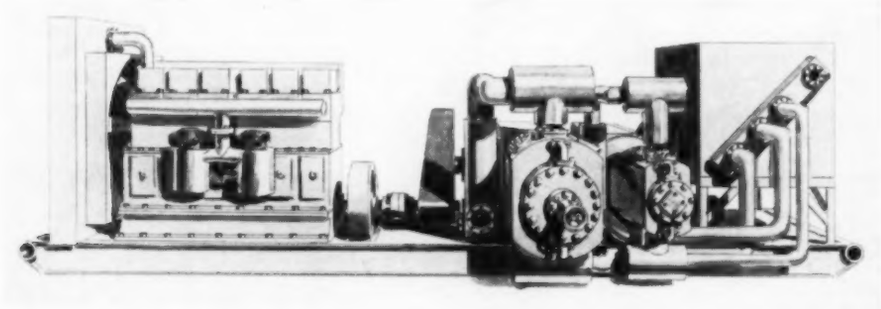
The main pulling force is carried by a tractor drawbar, eliminating the possibility of damage to the transmission case. Field tests prove the ripper can speed up loading in hard formations by 33 percent.

The Wadsworth ripper is hydraulically actuated. The low mounted, compact cylinder and link motion allows for maximum safety and full vision for the operator. The toggle type link mechanism requires less cylinder force to hold the tool in the ground. Cylinders pull standards into the ground and eliminate bent piston rods.

The rigidly-mounted adjustable standards allow positive ripping on the edge of cut to full width of tractor. It eliminates "dodging" boulders or rough formations. Standards are adjustable to depth in three steps of six inches each without disturbing the ripping action.

A minimum of tractor weight is necessary to hold tool in the ground, allowing the tractor to develop maximum traction. Offset mounted standards eliminate fouling and allow easier passage of ripped material. The maximum depth of penetration is 30 inches and frame clearance is 12 inches.

For more data circle **No. E1** on Readers' Service Card, last page this issue.



Gas Pickup Compressor

A compact, reciprocating compressor of use in the petroleum, petrochemical and mining industries has been announced by The Cooper-Bessemer Corporation. Known as the FMP, the compressor ranges in capacity from 100 to 300-horsepower and is expected to find use in field gathering systems, in gas lift operations, repressuring and booster service installations.

Basic engineering developments already perfected and used in Cooper-Bessemer's Type GMXD, V-angle compressors have been incorporated in this newest unit. Cylinders of the compressor can be mounted singly for single-stage compression, in tandem or as twin units for two or more stages, adapting the unit to a wide range of services.

The FMP compressor can be skid-mounted to operate as a portable unit or can be mounted on a conventional concrete base. The compressor may be belt-driven from an electric motor or power-driven from a conventional gas or diesel engine.

(This item supplements Cooper-Bessemer Corporation data on Page 1345 of the Composite Catalog, 21st Edition.)

For more data circle **No. E2** on Readers' Service Card, last page this issue.

Crawler Tractor

Announcement is made by the Industrial Sales Division, The Oliver Corporation, of an improved crawler tractor having many new design features. Powered by an Oliver full diesel engine delivering 161-horsepower and weighing 32,500 pounds, the tractor mounts a full line of matched allied equipment.

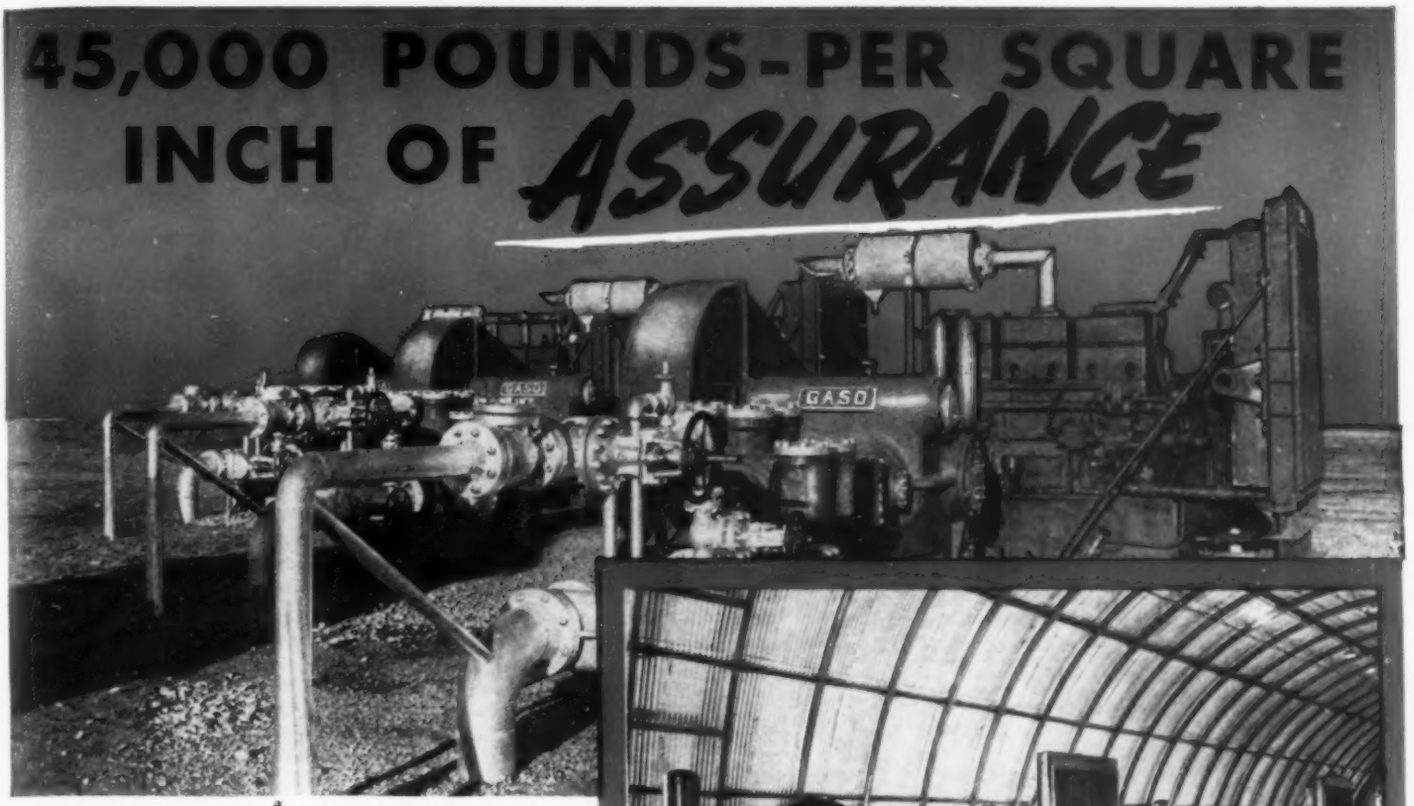
A new steering principle, incorporated in the design, combines the advantages of Oliver's controlled differential steering with the advantages of clutch steering. The new Power-Turn innovation permits operators to make spot turns or gradual turns at any angle. Another feature of Power-Turn is that without shifting, the operator can decrease speed by 38 percent with an increase in drawbar pull or push of up to 60 percent depending on weight and traction.

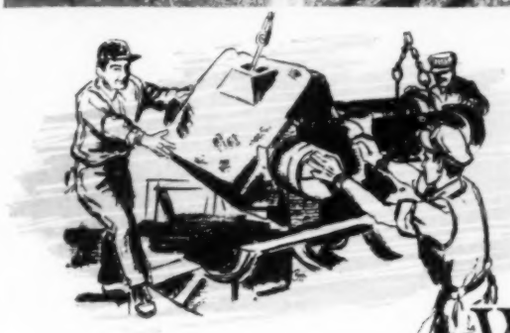
Other improvements have been made to the heavy-duty track frame and tracks, and use of a more rugged and efficient transmission has been announced. A Hi-Life wheel system featuring anti-friction bearings also is available.

For more data circle **No. E3** on Readers' Service Card, last page this issue.

Save time! Keep informed! Circle numbers on Readers' Service Cards, last page this issue

45,000 POUNDS-PER SQUARE INCH OF *ASSURANCE*





. . . With Every GASO PUMP

● The men in this picture are laying the foundation for the brand of service that has established Gaso Pumps as the favorite of oil men throughout the free world.

They are preparing the mold for the power frame of a Gaso Pump. Into it will be poured a formula of molybdenum alloy cast iron tested, refined and improved over a period of more than a third of a century. Test bars of the metal are sent regularly to a nationally known laboratory for tests. Consistently the tests show a tensile strength per square inch of 45,000 to 48,000 lbs.

It is this emphasis on strength and performance, carried through every detail of design, that gives Gaso users the assurance of extra life, extra service, extra returns on their pump investment.

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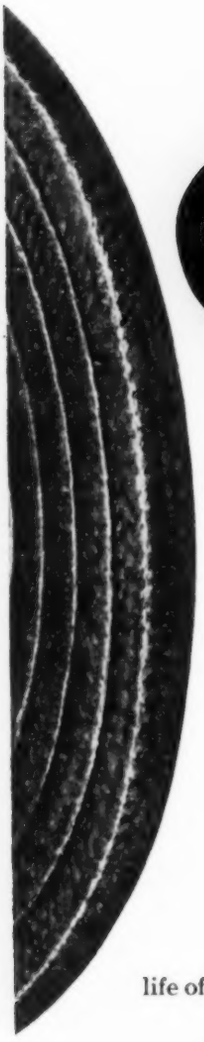
ONE OF THE GARLOCK 2,000

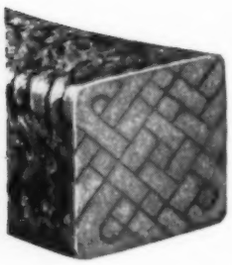


SERVICE REPORTS ON THIS PACKING EVEN SURPRISED US!

Typical Service Reports on Lattice Braid Asbestos Packing with Teflon:

- Outlasted another Garlock Style 10 to 1 against blending waxes and steam for cleaning.
- Outlasted competitor's packing 38 to 1 against caustic at 325°F., 50 psi.
- Outlasted other packings 3 to 1 against cold water.

Don't take our word for the greater strength, longer life of LATTICE BRAID with Teflon—try an initial order of 10 or more feet today. The Teflon core and impregnation resist everything except molten alkali metals and some freons.



And, remember, LATTICE BRAID with Teflon is only one of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals to meet every conceivable need. It's the *only* complete line available. It's one reason why you can expect unbiased recommendations from your Garlock representative. Call him, or write for booklet 131.

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Palmyra, New York

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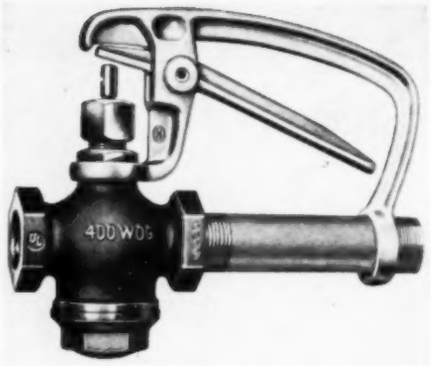
GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints



Bronze Valves

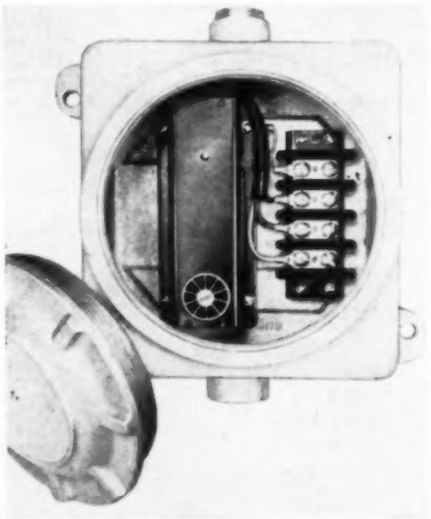
Ohio Brass Company announces two bronze valves especially designed for liquefied petroleum gas service.

The lever-operated valve, above, has a special safety feature to reduce chances of burns when LPG is being transferred from tank to tank. Designed for use as a nozzle, the valve permits back pressure to escape the direction away from the operator. It is recommended for use on pressures up to 400 pounds gas, oil or water, and is available in three sizes, ⅓, ¾ and 1-inch, complete with malleable iron handle and 6-inch pipe nipple.

The second valve, also for up to 400 pounds, gas, oil or water, has the conventional globe valve design. It features an outside bonnet and slip-on disc holder to aid in changing discs. It has the free swivel action between disc holder and stem, contributing to longer disc wear. The valve comes in nine sizes, ⅜ through 3 inches.

Discs and packing in both valves are made of Buna-N.

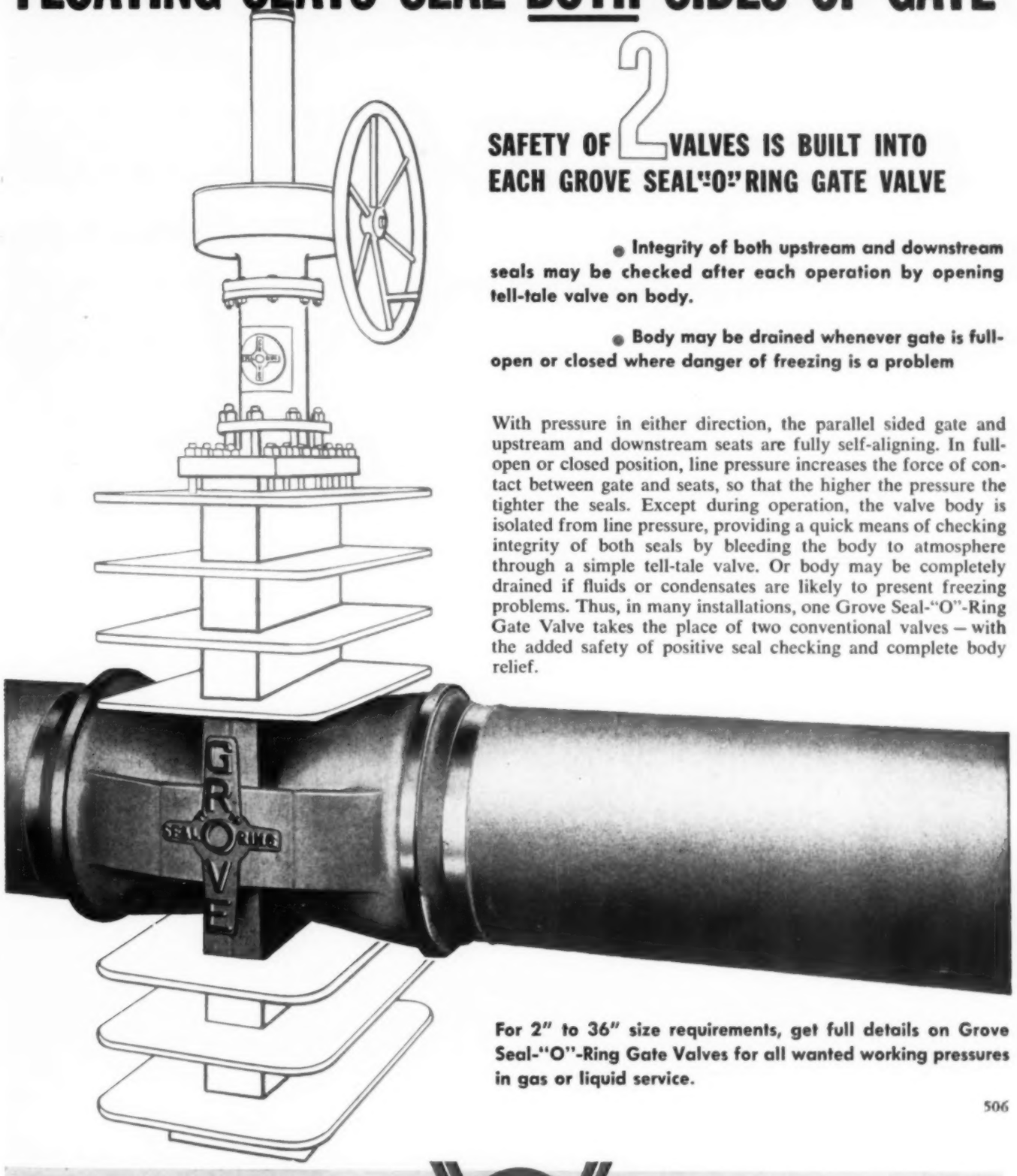
For more data circle **No. E4** on Readers' Service Card, last page this issue.



Vibration Monitor

The Beta Corporation's new explosion proof vibration monitor detects mechanical malfunction, such as failing bearings or unbalance, on gas engines, pump motors,

FLOATING SEATS SEAL BOTH SIDES OF GATE



SAFETY OF 2 VALVES IS BUILT INTO EACH GROVE SEAL-"O"-RING GATE VALVE

- **Integrity of both upstream and downstream seals may be checked after each operation by opening tell-tale valve on body.**

- **Body may be drained whenever gate is full-open or closed where danger of freezing is a problem**

With pressure in either direction, the parallel sided gate and upstream and downstream seats are fully self-aligning. In full-open or closed position, line pressure increases the force of contact between gate and seats, so that the higher the pressure the tighter the seals. Except during operation, the valve body is isolated from line pressure, providing a quick means of checking integrity of both seals by bleeding the body to atmosphere through a simple tell-tale valve. Or body may be completely drained if fluids or condensates are likely to present freezing problems. Thus, in many installations, one Grove Seal-"O"-Ring Gate Valve takes the place of two conventional valves – with the added safety of positive seal checking and complete body relief.

For 2" to 36" size requirements, get full details on Grove Seal-"O"-Ring Gate Valves for all wanted working pressures in gas or liquid service.

506

GROVE SEAL-"O"-RING Gate Valves

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GROVE SEAL RING — GROVE — SIMPLICITY ACCURACY SAFETY

For more data on advertised products, use Readers' Service Cards, last page.

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large fans and blowers and like applications. The unit offers 24-hour supervisory protection for infrequently attented equipment by actuating a warning or causing a shutdown the instant a malfunction develops.

The instrument may be provided with either a SPDT or a DPST normally open switch. An adjustment provides for a wide range of normal vibration levels. Electrical rating is 5 amperes, at 115 or 230 V.A.C. resistive or inductive.

Aluminum explosion proof housing is designed for Class I, Group D, Class II, Groups E, F and G, and Class III locations. It also is available in weatherproof housing with external reset operator and locking means.

For more data circle **No. E5** on Readers' Service Card, last page this issue.

Automatic Control Valves

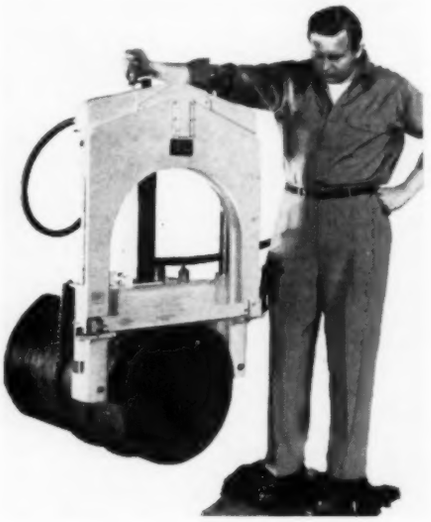
The Hammel-Dahl Company has announced a new standard line of control valves, the S-3000 series, which represents the first basic departure in control valve design overcoming present day limitations.

These valves of single seat construction will be offered in nominal sizes from one-half inch through eight inches. The new body design provides an extra large bowl capacity to insure a high coefficient of flow without involving excess body weight. The need for a blindhead is eliminated since all internal parts are removable through the valve bonnet and action may be reversed by inverting the superstructure. Plugs in valves two inches and larger are of balanced design and can be supplied with a special device for tight shutoff.

Illustrated here is a valve assembled for air-to-open action. By inverting this topworks without interferring with the open yoke or releasing compression of the stem packing, this valve is converted to air-to-close action.

The Hammel-Dahl positioner, balanced plug, high Cv body, correct spring range, low hysteresis, reversible superstructure and optional tight shutoff make the S-3000 series a versatile performer in the control valve field. The valve can be converted with standard parts into a special valve providing balanced control with tight shutoff at any temperature and pressure conditions.

For more data circle **No. E6** on Readers' Service Card, last page this issue.



Power Pipe Saw

Big Guillotine, The E. H. Wachs Company's new large capacity power pipe saw, cuts cast iron or steel pipe up to 16 inches in diameter on the job in a matter of minutes. Based on the original Wachs guillotine saw design, the Big Guillotine will cut 10-inch, 12-inch, 14-inch and 16-inch cast iron and steel pipe in a space only 32 inches wide.

Double chain pipe vise clamps the saw to pipe, ready to cut, in a matter of seconds. Machined cast steel V saddle base assures a square cut at right angle to pipe. Pipe acts as machine tool base.

For more data circle **No. E7** on Readers' Service Card, last page this issue.

GUNITE COATINGS for PIPE LINES
Reinforced GUNITE COATING being applied to pipe.
Your inquiry solicited.
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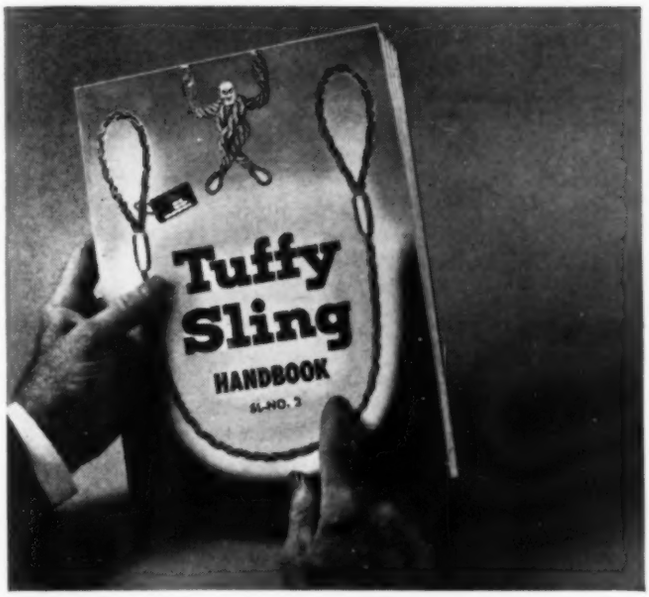
Tuffy® SLING NEWS

Vol. 1 Published Monthly in Leading American Trade Magazines by Union Wire Rope Corp. No. 4

HOW NEW FERRULE WORKS IS SHOWN IN FREE SLING BOOK



Ferrule Story, Facts on Fittings and Slings In Useful New Edition

This new and enlarged edition of the Tuffy Sling Handbook is an absolute "must" for plant and safety engineers, purchasing agents and shop foremen—everyone who uses, buys, or supervises work with slings. We distributed more than 85,000 copies of the first edition, and the demand for this new, completely revised edition is going to be even greater.

Featured in our new Sling Handbook is the new Tuffy streamlined metal ferrule pressed on the tucked eye splice. This new Tuffy Sling Handbook lists nearly a dozen new fittings—sling bridles, slip-on thimbles, safety hooks, sling saddles, horizontal clamps, and many others. It tells you all about the enlarged line of factory-fitted Tuffy Slings. It contains a complete rigger's manual, proof-tested rated working loads and specifications on all Tuffy Slings.

It's Yours Free, but our supply is going fast. So mail the coupon now for your copy of this valuable Tuffy Sling Handbook.

SEE DISTRIBUTOR FOR TUFFY SLINGS AND HOIST LINES

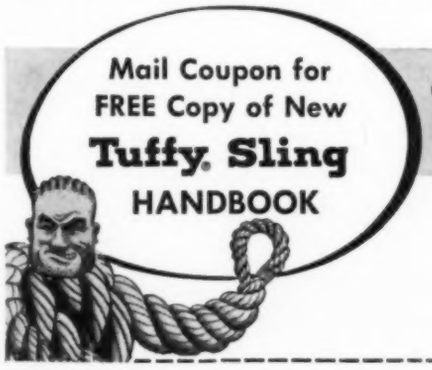
He can save you the time and trouble of carrying a full inventory. Tell him your normal requirements and he will keep matching stock of Tuffy Slings and Tuffy Hoist lines for fast delivery. Your Tuffy distributor can supply longer sling service life—bigger value for your money.

New Tuffy Ferrule Exclusive Feature at No Extra Cost

Union Wire Rope developed the new Tuffy Sling ferrule to make Tuffy Slings easier, safer, and faster to handle. It took extensive research and proof testing to improve upon the full length hand splicing of Tuffy Sling eyes which have withstood the test of time. Now equal or greater strength is attained with ferrule splice and the hazards of protruding tuck terminals are eliminated. Yet it costs you nothing extra for this exclusive feature.

Strength of Tuffy Fabric Now Equaled in Splice

First, the 9-part machine braided Tuffy Fabric of the sling eye is tuck-spliced together. Then the new Tuffy steel ferrule is slipped around the splice. Under terrific pressure, the metal of the ferrule (see cross section of splice and ferrule above) virtually flows into the interstices of the machine braided fabric. Every Tuffy sling is given strength at the eye splice equal to the superior strength of the machine braided fabric. The swaging of the ferrule at the ends makes them smooth, so they can't injure hands or catch on loads.



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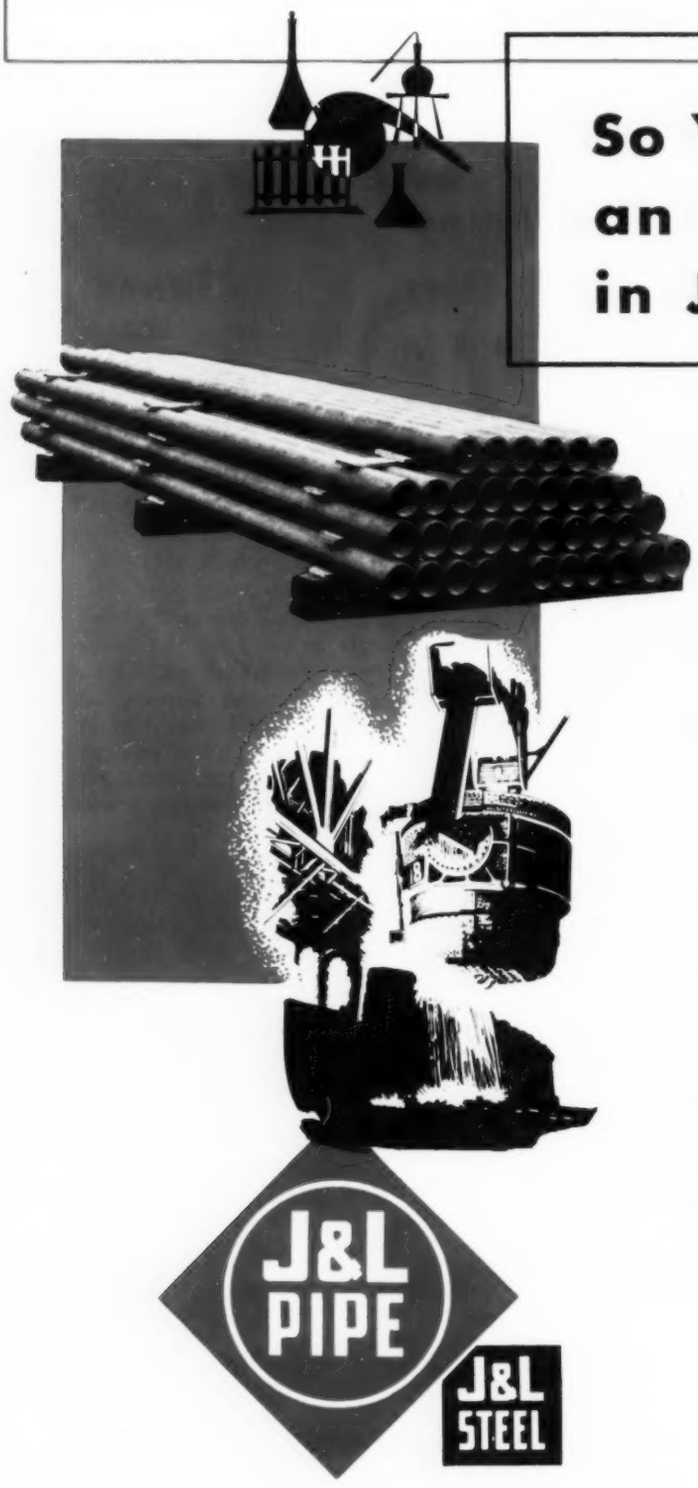


So You Have an Important Stake in J&L Research

Every man who buys or uses or is interested in the use of A.P.I. Tubular Products can observe the results of J&L research.

It is reflected in the adaptability and useful life expectancy of every length of J&L pipe, seamless or welded.

It is reflected in the excellence of the technical services of J&L Supply Men actively and enthusiastically interested in helping you get maximum dividends from your pipe investments.

Jones & Laughlin

SUPPLY DIVISION – Tulsa

SERVING THE UNITED STATES AND CANADA

3-1

New Equipment Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card.

Products Handbook

"Johns-Manville Products Handbook" is title of a new publication featuring 11 lines of J-M products for industry. The handbook contains not only product descriptions and essential engineering data but also a great deal of related information. For example, on the subject of thermal insulation problems, the booklet gives methods of calculating heat transmission, tables on heat losses from bare surface and equivalent thicknesses of pipes, and graphs on surface resistance for both pipes and flat surfaces.

To get a copy circle **No. E8** on Readers' Service Card, last page this issue.

Horizontal Compressors

Single-stage horizontal compressors (HB Belt drive and HS Steam drive) from 50 to 2000 cubic feet per minute and from 10 to 150 pound per square inch is subject of a new bulletin by Worthington Corporation. Information is presented on basic specifications, standard equipment, running gear parts, capacity control, cylinder construction, feather valves and special applications.

A diagram drawing of a complete compressor installation is included along with various cutaway views of major components and accessories. Several photographs of actual installations are included as well as a general data chart.

To get a copy circle **No. E9** on Readers' Service Card, last page this issue.

Pumping Station Control

Minneapolis-Honeywell Regulator Company describes functions of pipe line pumping stations, various types of pumping equipment, and control systems for regulation of pumping operations in the latest company brochure. Entitled "Control Systems for Liquid Petroleum Pumping Stations," the publication features schematic drawings and photographs to illustrate text material.

To get a copy circle **No. E10** on Readers' Service Card, last page this issue.

Trencher Bulletin

The complete line of Cleveland trenchers and backfillers — eight models for a variety of applications—is described in a bulletin newly-published by the Cleveland Trencher Company. Revisions in specifications of the Model 80W backfiller is the principal difference in text matter between this and the previous full line Cleveland bulletin.

The bulletin provides a quick, convenient comparison of capacities, specifications and dimensions of Cleveland's six trencher models and two backfiller models. Text points out special Cleveland design and construction features incorporated in each model. Action photos show Clevelands at work on all kinds of trenching projects.

To get a copy circle **No. E11** on Readers' Service Card, last page this issue.

Cathodic Protection Catalog

Pipe Line Anode Corporation has issued some new brochures and revisions for addition to their "Cathodic Protection Materials" catalog. Included in this material are brochures on the Westinghouse rectifiers and the Anaconda cathodic protection cable.

The new QA type anodes manufactured by National Carbon Company, a useful tool for cathodic protection work, is described. The QA idea has been adapted to the conventional 3 by 60-inch graphite anode, and there is now available from stock a type NA rod with a foolproof connection 15 inches down in the rod and a connector that permits any size or length lead.

To get a copy circle **No. E12** on Readers' Service Card, last page this issue.

Valves

Automatic Tool and Manufacturing Company has released a brochure on the Branson combo valve for automatic tank control systems. The booklet presents information on the dump valve, shutoff valve, unloading valve and auto level valve, along with dimensions, weights and material specifications.

To get a copy circle **No. E13** on Readers' Service Card, last page this issue.

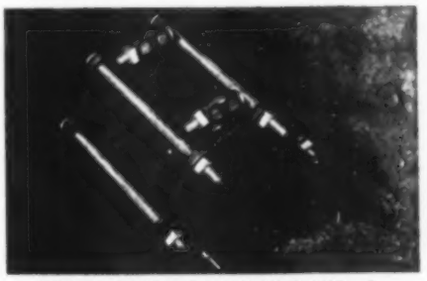
Scrubbers

Chemical Construction Corporation has released two new bulletins on the Pease-Anthony cyclonic scrubber and the Pease-Anthony venturi scrubber. These two types of gas scrubbing equipment have been found effective in removal of dust and mist from gases, recovery of metals and chemicals, and absorption of odors. Performance data, advantages of the scrubbers, and operational information are available in these bulletins.

To get a copy circle **No. E14** on Readers' Service Card, last page this issue.

REPAIR LEAKS
QUICKLY — PERMANENTLY

SKINNER-SEAL PIPE JOINT CLAMPS stop leaks at joints. Put on under pressure — without interruption of service. Quick, simple, lasting repair. Sizes 1/2" to 24" incl. in stock.



SKINNER-SEAL COLLAR LEAK CLAMP — designed to stop every type of collar leak in oil and gas lines. Sizes: 2" to 13" inclusive.

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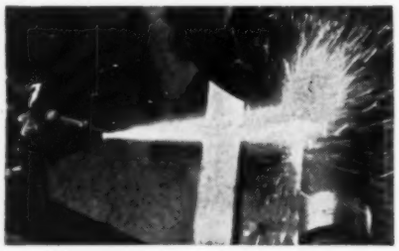
METALLIZING



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2825 Storey Lane, Dallas, Texas

AMERICAN SAND-BANUM CO.
ESTABLISHED 1926
MEADOW BROOK NATIONAL BANK BUILDING
FREEPORT, NEW YORK

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No change except the corporate name. We still have the same ownership, same management, same address, same telephone, and use the same 45 years of experience to render the same service under the same trade name—"PELCO."

PELICAN SUPPLY CO. INC.
P. O. Drawer 1108 Shreveport (84), La.
SEE YOUR NEAREST SUPPLY HOUSE

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Use these cards to help keep informed on what's new . . . for more job-help information on equipment and services.

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☐ Check here for 1955 Index

ADVERTISEMENTS—Circle page number of ad for more product information:

2	5	7	9	10	11	12	13	14	15	41	43	45	47	48	49	50	51	52	53
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89	91	92	93	94a	94b	94c	95	96	97a	97b	98a	98b	98c	101	102				

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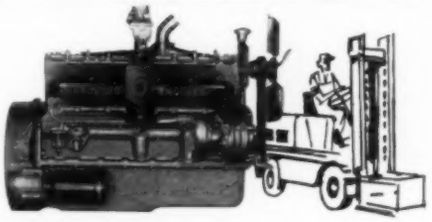
HOUSTON 1, TEXAS, U. S. A.

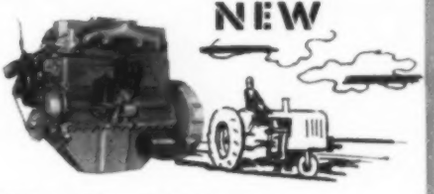
Quick-Easy

Use these cards to help keep informed on what's new . . . for more job-help information on equipment and services.

NOW . . . all types of engines from one dependable source

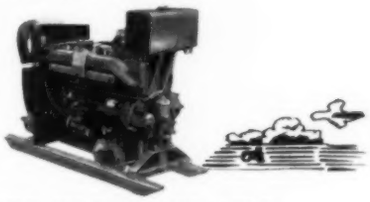


L-HEAD GASOLINE — Compact and especially adaptable for installations where space is limited.

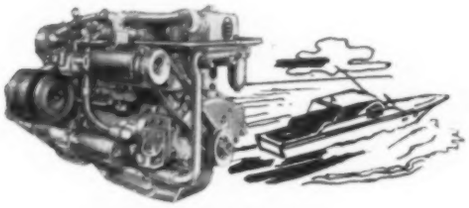


NEW

DD-SERIES — Direct injection Diesel. 12 models INTERCHANGEABLE with GO-Series gasoline engines.



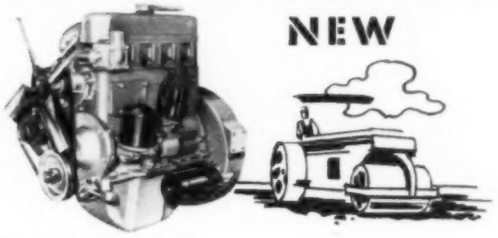
L.P.G. NATURAL GAS or KEROSENE engines are available in 40 models also popular sizes for irrigation service.



MARINE DIESEL ENGINES — Sizes from 75 to 500 H.P. for workboats and pleasure craft.

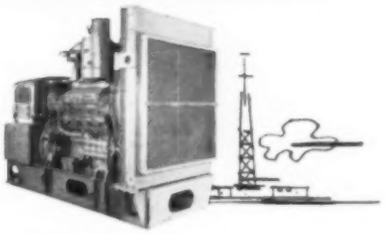
PRODUCTS OF

HERCULES engine manufacturing specialists



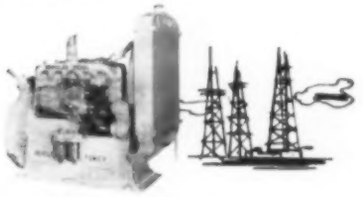
NEW

GO-SERIES — Gasoline Overhead valve engines. Available in 12 models.



SUPERCHARGED DIESELS — Maximum power for special installations such as micro-wave generator sets for coast-to-coast T.V.

TURBULENCE CHAMBER DIESELS — 32 models to 500 H.P. in 1, 2, 4, 6 and 8 cylinders.



POWER UNITS — Open, closed or base type units are available in most models of gasoline and diesel engines.

NOW . . . with the addition of the G O series (Gasoline Overhead valve) and the D D series (Direct injection Diesels), Hercules Motors Corporation offers a most extensive line of piston type engine to meet the varied needs of modern industry.

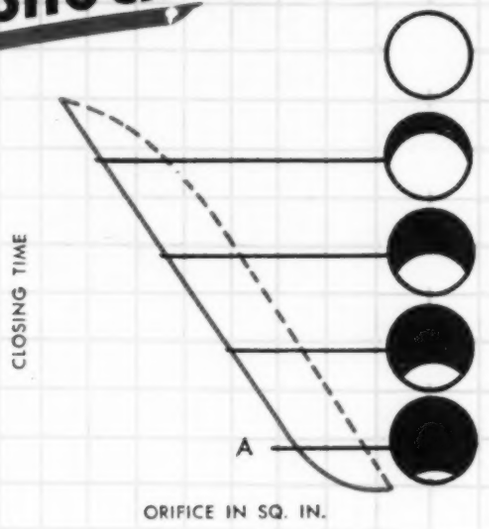
In addition to the many types of engines illustrated above, it is the policy of Hercules Motors Corporation to tailor engines to the special requirements of their manufacturing customers. Special versions of regular models — for example, "pancake" or flat engines — are often produced for particular applications.

Whatever your power requirements may be, HERCULES — Engine Manufacturing Specialists Since 1915 — will be happy to work with you and solve your power problems. For more information on the new G O and D D series — or any type of Hercules Engine from 3 to 500 H.P. contact the factory.

HERCULES MOTORS CORPORATION

CANTON 2, OHIO

W-K-M Eclipse Closing . . . takes the SHOCK out of Line Surge



Dotted line shows closing curve of conventional gate valve.

• Regardless of volume or pressure flowing through a W-K-M Valve, it can be closed as fast as required without setting up dangerous surges. In W-K-M Through-Conduit Valves the basic design of the gate and segment provides the right variable ratio of port area to gate travel to close the valve without surging.

The no-surging action of eclipse closing is illustrated by the curve above. From full-open to point A, the rate of closing is almost a straight line. From point A (about 70% closed) the rate of close slows as it approaches the fully-closed position. This gradual close-off at the critical point brings the flow through the valve to a smooth stop rather than a sudden halt—consequently there is no surging.

In addition to this fine feature W-K-M Through-Conduit Valves have many others that make them the leader in long-life, trouble-free performance for every purpose.

W-K-M Valves

W-K-M MANUFACTURING COMPANY, INC.

A SUBSIDIARY OF acf INDUSTRIES INCORPORATED

P. O. Box 2117, Houston 1, Texas Los Angeles, California

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